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ABSTRACT

Because of the high rate of failure of engineering students in a required engineering physics course at the University of Texas at Austin, College Board Achievement Test (CBAT) scores in Mathematics Level 1 for 537 students enrolled in the course were compared with their physics grades. Performance on the mathematics section of the Scholastic Aptitude Test was also investigated. Since the correlation between scores and grades proved inadequate, 283 students beginning the physics course took the CBAT in physics for later correlation with final course grades. This, in combination with CBAT Mathematics Level 1 scores, provided an adequate correlation, but one which might detour too many students into an introductory physics course. Therefore, performance in the required physics course of those students who had taken introductory physics was compared with that of students who had not. When correlated with performance on the CBAT Mathematics Level 1 scores, three cutoff scores were identified: (1) scores of 600 or below strongly suggested enrollment in the introductory physics course; (2) scores between 610 and 680 indicated a borderline area; and (3) scores above 690 indicated readiness for the required physics course. (Appendices include sample CBAT items and instructions for students; student questionnaire items; and a letter from the chairman of the physics department setting forth the cutoff score recommendations). (MGD)

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VALIDITY STUDIES OF COLLEGE BOARD ACHIEVEMENT TESTS IN PHYSICS AND MATHEMATICS FOR USE IN COURSE PLACEMENT IN ENGINEERING PHYSICS AT U.T. AUSTIN, 1981-1983

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and H. Paul Kelley

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Anne B. Appenzellar, Barbara G. Dodd, and H. Paul Kelley

During the spring semester of 1982, the Department of Physics at The University of Texas at Austin, represented by two senior faculty members, asked the staff of the Measurement and Evaluation Center (MEC) to review their faculty's concerns about a high rate of student failure--estimated to be approaching 50%--in Physics 303K. Successful performance in this course, known as Engineering Physics, is required of its students by the College of Engineering at U.T. Austin, normally during the students' first semester at the University, along with concurrent enrollment in (or credit for) Physics 103M, an accompanying laboratory course, and a one-semester college-level calculus course.

As a first step, MEC staff members analyzed scores made on The College Board Achievement Test in Mathematics Level I by 537 students who had received letter grades F to A in both the lecture (Physics 303K) and laboratory (Physics 103M) courses and who had also taken the Achievement test prior to taking the courses. These students constituted 55% of the 973 students enrolled in Physics 303K during the fall semester of 1981. In addition, the students' performances on the Mathematical section of the Scholastic Aptitude Test (SAT-M) were investigated, both separately and in combination with the Achievement test scores, in relation to the final grades earned by the students in Physics 303K.

Because the correlation coefficients of the two test scores, separately or in combination, with Physics 303K course grades failed to reach the customary range of .40 or higher, the faculty members approved an MEC recommendation for a second study--that students enrolling in Physics 303K during the fall semester of 1982 be examined with The College Board Achievement Test in Physics at the beginning of the course and that their scores be correlated with final course grades at the end of the semester. In addition,

MEC staff members retrieved from University records and then analyzed the students' scores on the Mathematics Level I test taken prior to the courses in relation to their performances in Physics 303K and Physics 103M.

While satisfactory correlation coefficients were obtained in this second study, members of the Department of Physics were reluctant to select a decision score on either Achievement test (or a combination of both) as a prerequisite for enrollment in Physics 303K. Instead, they asked MEC staff members to investigate the effects of student performance in an introductory course (Physics 306) upon subsequent performance in Physics 303K.

This report, therefore, presents the results of three separate, but related, studies. Studies 1 and 2 describe the first two phases of the investigation; Study 3 reports on the analyses of the performance in Physics 303K of students who had taken Physics 306 in comparison to the performance of students who had not taken Physics 306. Study 3 also examines the relationships of student performance in both course sequences to student performance on the Mathematics Level I test. The report concludes with statements of MEC recommendations to the department and the decisions made by the Physics faculty.

Studies 1 and 2

Methods

Subjects. Study 1 analyzed already-available data on test and course performances of a group of students who took Engineering Physics (Physics 303K) during the fall semester of 1981, while Study 2 gathered and analyzed data for another group of students who took the course during the fall of 1982.

Physics 303K is designed as a first semester lecture course in college physics for engineering students; other students are also permitted to enroll in the course. It is a survey of physics, primarily covering the laws of motion, heat, and wave phenomena. Its prerequisites include high school study of physics and credit (or concurrent registration) for calculus (Mathematics 808A, 608EA, 608EB); concurrent registration for its laboratory complement, Physics 103M, is also required.

During the first study (summer of 1982), Measurement and Evaluation Center staff members retrieved data from University records for 973 students who had enrolled in Physics 303K during the fall semester of 1981. The analyses were based on data for the 537 (55%) students who had received letter grades F through A in both the lecture and the laboratory courses and who also had taken the Achievement Test in Mathematics Level I.

Study 2 involved administration of the Achievement Test in Physics during the fall semester of 1982. At the request of the department, five instructors of Physics 303K sections agreed to participate in the study; one of the five taught two sections. The anticipated number of student participants was 1,068 because each of the six sections was assigned 178 students; the actual number of students who took the test was only 580 (54%), however, as student participation was not officially required. For purposes of the analyses, this group of 580 was reduced to a subgroup of 283 students who were enrolled in the College of Engineering and who had the following characteristics in common: (a) they had no prior credit in college physics; (b) they had enrolled in Physics 303K for the first time, with concurrent enrollment in Physics 103M; (c) they had prior credit for, or concurrent enrollment in, calculus (M 808A, M 608EA, or M 608EB); (d) they had taken the Achievement Test in Mathematics Level I, and (e) they had received a letter grade (F, D, C, B, or A) in Physics 303K. (For more detailed profiles of both the total group of 580 and the select subgroup of 283, see Tables A and B in Appendix B.)

Materials. The College Board Achievement Test in Physics is designed to measure student achievement in those aspects of the subject that are emphasized in high school physics courses for college-bound students, regardless of differences in their approaches to the subject. The emphasis of the one-hour test is upon the use of major principles of physics, often in unfamiliar situations.

The 75 questions are distributed approximately as follows across the major areas of physics: mechanics, 40%; electricity and magnetism, 20%; optics and waves, 20%; atomic and nuclear physics, 10%; heat and kinetic theory, 10%. Scores are reported on a scale of 200 to 800, with the third

digit always zero. A description of the test and a set of sample questions are included in Appendix A.

In addition to the test items, students were asked to respond to seven questions designed to elicit information about their prior study or general knowledge of physics, whether acquired in junior/senior high school courses in physics, general science, or natural sciences, or in college courses. A copy of these questions is included in Appendix B, along with group profiles based on responses to the seven questions (Table A).

As the material in Appendix A indicates, scores on the Physics Achievement test, whether administered in national test centers or on the U.T. Austin campus, are evaluated for credit by examination in Physics 302K (General Physics: Mechanics, Heat, Sound) and its accompanying laboratory course (Physics 102M) and for Physics 302L (Electricity, Magnetism, Light, Atomic and Nuclear Physics) and its accompanying laboratory course (Physics 102N); the minimum score for credit is 580. Also, it should be mentioned that scores on The College Board Advanced Placement Examination in Physics C, Part I - Mechanics are evaluated for credit by examination in Physics 303K/ Physics 103M or Physics 301 (Mechanics) and its accompanying laboratory course (Physics 101L); the minimum score for credit is 3.

The College Board Achievement Test in Mathematics Level I is a broad-ranging test of 50 questions, each with five choices, that is designed to measure the achievement in high school mathematics of students who have had three years of college preparatory mathematics. It allows one hour of testing time. About half of its questions deal with topics from algebra (30%) and plane Euclidean geometry (20%), while the rest covers solid geometry (6%), coordinate geometry (12%), trigonometry (8%), functions and miscellaneous topics (12% each). Scores are reported on a scale of 200 to 800, with the third digit always zero.

While it is not expected that all students will have been exposed to all topics included in the test, attempts have been made to construct questions that all students can comprehend, regardless of the curriculum in mathematics to which they have been exposed. The sample questions provided

(see Appendix A) illustrate the kinds of knowledge and techniques required to perform well on the test.

Procedures

Data collection for Study 1 began in May of 1982, when MEC's data processing division established a data base from University files for the 973 students who had enrolled in regular sections of Physics 303K the preceding fall semester.

Among the major academic variables used in the analyses of Study 1 were the following 10: high school rank; Verbal, Mathematical, and Total scores from the Scholastic Aptitude Test; one score each from two College Board Achievement Tests (Mathematics Level I and Physics); final course grades in Physics 303K (Lecture GPA) and in Physics 103M (Laboratory GPA); a weighted grade point average (GPA) for both Physics courses combined (Physics GPA); a numeric Physics Code (1 or 2) for students with the unsatisfactory grades of F and D in one or both courses (Code 1) and for students with the satisfactory grades of C, B, and A (Code 2) in both courses.

Analyses performed in Study 1 included intercorrelating values of all 10 of the above variables; computing regression equations to predict the three final course grades from the two Achievement test scores, separately and combined, and combined with high school rank; computing predicted grades in Physics 303K and in the two physics courses combined; computing frequency distributions of (a) Mathematics Level I scores, (b) predicted GPAs for Physics 303K, and (c) predicted GPAs for both courses combined--all three tabulated according to each of the three criterion measures: final course grades in Physics 303K (Lecture GPA), both courses combined (Physics GPA), and Physics Code.

In Study 2, the Achievement Test in Physics was administered by MEC staff members in several of the larger classrooms on campus each of two successive evenings during the first week of classes in the fall semester of 1982. The arrangements were announced by the five instructors during the first meetings of their sections. In addition, students were given a handout detailing the testing date assigned to each section, the time and place of the examinations, what to do in case of a conflict, and the general purpose

of the study. Upon request, make-up examinations were given to 16 students who missed the scheduled administration.

The final grade in the course was used as the criterion measure of success or failure in Physics 303K. Letter grades F to A were obtained from University records by the MEC's data processing division.

In addition to Achievement test scores in both physics and mathematics, the design of the study provided for collection of values on 30 other variables that might be useful as predictors of course performance, including the three scores from The College Board Scholastic Aptitude Test (SAT) and the five scores from the ACT Assessment of the American College Testing Program (ACT), and scores on The College Board Achievement Test in English Composition (ECT). The students' grades in Physics 303K and Physics 103M were secured, along with a grade point average of final course grades in Physics 303K and Physics 103M combined.

Analyses prepared for the department included (a) tables of descriptive statistics on 17 variables for both the total group tested and a special subgroup representing the engineering students for whom the course was designed; (b) for both the total group and the special subgroup, intercorrelation matrices based on eight variables of major interest (five course grades and three test scores); (c) for the special subgroup only, three sets of four tables each that presented frequency distributions of scores on various predictor variables in relation to final course grades in Physics 303K, estimates of the predictive accuracy of a selected group of possible decision (cutting) scores, and six guidelines that are often used by academic departments to select minimal decision scores for course placement.

Results: Study 1

Analyses of data in Study 1 were based on all students, regardless of their college of enrollment, who received letter grades (F - A) in both the lecture (Physics 303K) and laboratory (Physics 103M) courses and who also had taken The College Board Achievement Test in Mathematics Level I.

Of the 973 students enrolled in the two Physics courses during the fall of 1981, the requisite data were available for 537 (55%). As shown in

Table 1.1, the mean (average) Mathematics Level I test score was 593.56; the variability of the scores, as expressed by the standard deviation, was 74.70. On the 0-4 grade point scale used at U.T. Austin, the mean final grade of the 537 students in the lecture course was 1.88, or a little less than C (2.00); the standard deviation was 1.37.

Analysis of the relationship between student scores on the Mathematics Level I test taken prior to enrollment in the course and subsequent performance in the lecture course yielded a coefficient of correlation of only .3368. This predictive validity coefficient decreased slightly to .3355 when final grades in the laboratory course were included in the measure of student performance. The validity coefficient could not be greatly enhanced by use of the Mathematical scores from the SAT as an additional predictor variable. (For a smaller group of 485 students who had SAT-M scores, Mathematics Level I scores, and high school rank, the correlation coefficient of SAT-M scores with Physics 303K grades was .2984; with Physics 103M grades, .1155; with the grade point average for both courses combined, .2827.)

In addition to the descriptive statistics reported above, Tables 1.1 through 1.4 present the results of MEC analyses that begin with frequency distributions of test scores in relation to course grades, show the predictive accuracy that might have been obtained by use of selected decision scores, and suggest the decision score that would be suggested by each of six decision-making guidelines.

Table 1.1 distributes the Mathematics Level I test scores according to the letter grades assigned to the 537 students by their instructors; it also reports the mean and standard deviation of the scores for each of the five letter grade subgroups, F through A, and for the combined group; the mean and standard deviation of the course grades; and the correlation (validity) coefficient between the test scores and the course grades. In addition, Table 1.1 lists the grades that can be predicted for students who make various possible scores on the test (second column) and the test scores that can be expected for students who make each of the five possible grades in the course (bottom row).

Table 1.1

Beginning-of-Course Mathematics Level I Achievement Test Scores in Relation To Performance in Physics 303K: Frequency Distributions, Descriptive Statistics, Expected Grades, and Expected Scores

		Final Course Grades (0-4) in Physics 303K							
Test Scores	Expected Grades	(0) F	(1) D	(2) C	(3) B	(4) A	Total N		
750-800	2.85-3.16		1	1		4	6		
740	2.78					2	2		
730	2.72	1		1	1	1	4		
720	2.66			1	2	3	6		
710	2.60			1		5	6		
700	2.54		1	2	2		5		
690	2.47	2	2	5	3	4	16		
680	2.41	3	1	5	1		10		
670	2.35	3	1	6	5	7	22		
660	2.29	4	3	5	6	6	24		
650	2.23	6	5	2	7	6	26		
640	2.17	3	5	11	10	9	38		
630	2.10	5	4	9	10	7	35		
620	2.04	4	4	11	9	3	31		
610	1.98	7	7	7	9	7	37		
600	1.92	3	4	12	7	4	30		
590	1.86	9	11	5	8	5	38		
580	1.79	6	8	12	4	2	32		
570	1.73	9	1	1	3		14		
560	1.67	5	1	3	2		11		
550	1.61	3	6	3	2	2	16		
540	1.55	7	4	4			15		
530	1.48	5		5	1		11		
520	1.42	3	1	3			7		
510	1.36	6	2	5	1	2	16		
500	1.30	4	2	4	2	1	13		
490	1.24	3	2	3	1	1	10		
480	1.18	7	2		1	1	11		
470	1.11	2	1	3		1	7		
460	1.05	2	3	2		1	8		
450	0.99	3	2		2		7		
440	0.93	2	1	3		1	7		
430	0.87	3	2	1			6		
420	0.80	2		1			3		
410	0.74		1	1			2		
400	0.68			3			3		
390	0.62								
200-380	(-.56)-(.56)	1		1			2		
Total		123	88	142	99	85	537	Mean Grade	Standard Deviation
%		23%	16%	26%	18%	16%	100%	1.88	1.37
Mean Score		562	579	588	616	637	593.56	Correlation Coefficient r = .34	
Standard Deviation		73	71	78	54	71	74.70		
Expected Score		559	577	596	614	632			

Table 1.2

Beginning-of-Course Mathematics Level I Achievement Test Scores in Relation To Performance in Physics 303K: Combined Frequency Distributions And Regression Equations

	Preliminary Course Grades		
Test Scores	Unsatisfactory F,D	Satisfactory C-A	Total N
750-800	1	5	6
740		2	2
730	1	3	4
720		6	6
710		6	6
700	1	4	5
690	4	12	16
680	4	6	10
670	4	18	22
660	7	17	24
650	11	15	26
640	8	30	38
630	9	26	35
620	8	23	31
610	14	23	37
600	7	23	30
590	20	18	38
580	14	18	32
570	10	4	14
560	6	5	11
550	9	7	16
540	11	4	15
530	5	6	11
520	4	3	7
510	8	8	16
500	6	7	13
490	5	5	10
480	9	2	11
470	3	4	7
460	5	3	8
450	5	2	7
440	3	4	7
430	5	1	6
420	2	1	3
410	1	1	2
400		3	3
390			
200-380	1	1	2
Total	211	326	537
%	39%	61%	100%
Mean Score	569	609	593.56
Standard Deviation	72	72	74.70

Mean Grade	Standard Deviation
1.88	1.37

Correlation Coefficient

r = .34

Equations Used to Obtain Expected Values Shown in Table 1.1

Expected Scores (bottom row)
Expected Grades (second column)

Expected Score =

$$\left(\begin{matrix}\text{Prelim.}\\ \text{Grade}\end{matrix} \times 18.3169\right) + 559.1393$$

Expected Grade =

$$\left(\begin{matrix}\text{Test}\\ \text{Score}\end{matrix} + .00619\right) - 1.79615$$

Table 1.3

Beginning-of-Course Mathematics Level I Achievement Test Scores in Relation To Performance in Physics 303K: Possible Decision Scores and Corresponding Accuracies of Placement (N = 537)

	Cumulative Number of Students				Percent of Students in Each Placement Category				Overall Accuracy of Placement		
Placement Category	Unsatis-factory F,D (N=211)		Satis-factory C-A (N=326)		Unsatis-factory F,D		Satis-factory A-C		Accuracy Category	No. of Students	% of Students
630 - up	Too High	50	150	OK	Too High	24%	46%	OK	Too High	50	9%
									Correct	311	58%
Below 630	OK	161	176	Too Low	OK	76%	54%	Too Low	Too Low	176	33%
620 - up	Too High	58	173	OK	Too High	28%	53%	OK	Too High	58	11%
									Correct	326	61%
Below 620	OK	153	153	Too Low	OK	72%	47%	Too Low	Too Low	153	28%
610 - up	Too High	72	196	OK	Too High	34%	60%	OK	Too High	72	13%
									Correct	335	62%
Below 610	OK	139	130	Too Low	OK	66%	40%	Too Low	Too Low	130	24%
600 - up	Too High	79	219	OK	Too High	37%	67%	OK	Too High	79	15%
									Correct	351	65%
Below 600	OK	132	107	Too Low	OK	63%	33%	Too Low	Too Low	107	20%
590 - up	Too High	99	237	OK	Too High	47%	73%	OK	Too High	99	18%
									Correct	349	65%
Below 590	OK	112	89	Too Low	OK	53%	27%	Too Low	Too Low	89	17%
580 - up	Too High	113	255	OK	Too High	54%	78%	OK	Too High	113	21%
									Correct	353	66%
Below 580	OK	98	71	Too Low	OK	46%	22%	Too Low	Too Low	71	13%
570 - up	Too High	123	259	OK	Too High	58%	79%	OK	Too High	123	23%
									Correct	347	65%
Below 570	OK	88	67	Too Low	OK	42%	21%	Too Low	Too Low	67	12%
560 - up	Too High	129	264	OK	Too High	61%	81%	OK	Too High	129	24%
									Correct	346	64%
Below 560	OK	82	62	Too Low	OK	39%	19%	Too Low	Too Low	62	12%
550 - up	Too High	138	271	OK	Too High	65%	83%	OK	Too High	138	26%
									Correct	344	64%
Below 550	OK	73	55	Too Low	OK	35%	17%	Too Low	Too Low	55	10%
540 - up	Too High	149	275	OK	Too High	71%	84%	OK	Too High	149	28%
									Correct	337	63%
Below 540	OK	62	51	Too Low	OK	29%	16%	Too Low	Too Low	51	9%

Table 1.4

Beginning-of-Course Mathematics Level I Achievement Test Scores In Relation to Performance in Physics 303K: Scores Suggested By Six Guidelines for Use in Selecting Decision Scores (N = 537)

Guideline	Score
1. Expected Score for students whose performance in course was just minimally satisfactory (i.e., students with preliminary grades of C; see Expected Score row at bottom of Table 1.1).	600
2. Score for which Expected Grade was just minimally satisfactory (i.e., C; see Expected Grade column in Table 1.1).	620
3. Score for which percents of placement errors of students in each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal. (See % Too High and % Too Low values in middle columns of Table 1.3.)	600
4. Score for which overall percents of placement errors were most nearly equal. (See % Too High and % Too Low values in last column of Table 1.3.)	590
5. Score that would have cut off (or held back) approximately the same number of students as were in the Unsatisfactory performance group. (See Table 1.2 for number of students in Unsatisfactory group and the test score that most nearly identifies that number of low-scoring students.)	590
6. Score that would have maximized overall accuracy of placement. (See number correct in next-to-last column of Table 1.3.)	580

Table 1.2 collapses the five grade letter subgroups into two performance subgroups that are labeled Unsatisfactory (grades of F and D) and Satisfactory (grades of C, B, and A). It repeats the descriptive statistics and adds the regression equations that were used to compute the expected (predicted) grades and the expected scores reported in Table 1.1. Using the data reported in Table 1.2, Table 1.3 estimates the placement accuracy of each of 10 scores that might be chosen as decision scores. Placement accuracy is presented in terms of numbers and percentages of students, both for the Unsatisfactory/Satisfactory Performance subgroups and within the total group of 537 students.

With reference to the findings of Tables 1.1-1.3, Table 1.4 presents six possible guidelines for selecting a decision score. Evaluating the scores suggested by the various guidelines, the MEC staff considered the Mathematics Level I score of 600 to be the most promising. It was the expected score for students whose course performance was minimally satisfactory, and it was the score at which the percents of placement errors within each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal.

However, MEC staff members did not recommend to the Department of Physics that such a decision score on the Mathematics Level I test be implemented because of the relatively low predictive validity coefficient (.34) that had been obtained. Instead, they suggested that a second study be conducted in which The College Board Achievement Test in Physics would be administered at the beginning of the courses to all students enrolled in Physics 303K and 103M for the 1982 fall semester.

Results: Study 2

The purpose of the second study was to find out if use of the Physics test scores, alone or in combination with the Mathematics Level I scores, would increase the predictive validity coefficient appreciably.

Following the collection of data from 580 (54%) of the 1,068 students enrolled in Physics 303K during the fall of 1982, descriptive statistics were obtained for 32 variables to be used in the analyses planned by MEC

staff members. Tables 2.1 and 2.2 present the mean grades/scores, standard deviations, and the ranges of grades/scores for the eight variables of major interest (five course grades and three test scores); Tables 3.1 and 3.2 report the intercorrelations among those eight variables.

Tables 2.1 and 3.1 cite descriptive statistics and correlation coefficients, respectively, for all 580 of the students who participated in the administration of The College Board Achievement Test in Physics during the first week of classes. (It is assumed that all or most of the remaining 488 students, 46% of the total enrollment in the lecture class, failed to participate because the test was not officially required by the department.) Tables 2.2 and 3.2 provide the same information for a special group of 283 Physics 303K students who were enrolled in the College of Engineering and shared five additional characteristics: they had received no prior credit in college physics; they were taking Physics 303K for the first time; they were also enrolled in the laboratory course, Physics 103M; they had prior credit for or were concurrently enrolled in calculus (Mathematics 808A, 608EA, 608EB); they had taken the Mathematics Level I test; they received a letter grade (F - A) in Physics 303K.

A comparison of the larger group with the select group indicates that the latter students were better prepared for their study of engineering physics, as one might expect. For example, the mean score of the engineering students on the Physics test (544) was 11 points higher than that of the less homogeneous group (533); the select group scored 23 points higher (622) on the Mathematics Level I test than did the larger group (599). However, the two groups earned quite similar mean grades in the two Physics courses: 2.43 for the select group, 2.42 for the larger group. Because the select group received slightly higher grades in the lecture course, the weighted averages favored the engineers 2.25 to 2.23. The engineers' greater success in mathematics is confirmed by their average calculus grade, which reached 2.52, as compared to 2.43 for the more disparate group of students.

Comparisons of Tables 3.1 and 3.2 indicate, in general, a slightly higher correlation among the eight variables for the select group, but in most instances the difference is no more than .01 or .02. Of the three tests whose scores might be used as predictors of success in the lecture course, the Mathematics Level I test yielded the highest predictive validity

Table 2.1

Descriptive Statistics: Mean Grades/Scores, Standard Deviations, and Range of Values for Eight Variables for Total Group of Physics 303K Students Who Took the Physics Achievement Test, Fall 1982 (Maximum N = 580)

Variable	N	Mean Grade or Score	Standard Deviation	Range of Grades or Scores	
				Minimum	Maximum
Physics 303K Grade	542	1.99	1.25	0.00	4.00
Physics 103M Grade	544	2.79	1.07	0.00	4.00
Physics 303K, 103M Grade Average	512	2.42	0.98	0.00	4.00
Physics 303K, 103M Weighted Grade Average[a]	512	2.23	1.07	0.00	4.00
Calculus Grade	408	2.43	1.38	0.00	4.00
SAT Mathematical Score	495	598.85	76.56	320.00	800.00
Mathematics Level I Score	424	598.84	78.60	370.00	780.00
Physics Achievement Score	580	533.43	77.38	310.00	800.00

[a] The weighted average was obtained by use of the following formula:

$$\frac{3 \text{ Lecture} + 1 \text{ Laboratory}}{4}$$

Table 2.2

Descriptive Statistics: Mean Grades/Scores, Standard Deviations, and Range of Values for Eight Variables for Select Group of Physics 303K Students Who Took the Physics Achievement Test, Fall 1982 (Maximum N = 283)

Variable	N	Mean Grade or Score	Standard Deviation	Range of Grades or Scores	
				Minimum	Maximum
Physics 303K Grade	283	2.07	1.22	0.00	4.00
Physics 103M Grade	283	2.80	1.04	0.00	4.00
Physics 303K, 103M Grade Average	283	2.43	0.97	0.00	4.00
Physics 303K, 103M Weighted Grade Average[a]	283	2.25	1.06	0.00	4.00
Calculus Grade	267	2.52	1.37	0.00	4.00
SAT Mathematical Score	274	611.79	69.27	350.00	800.00
Mathematics Level I Score	283	622.44	69.40	410.00	780.00
Physics Achievement Score	283	543.85	77.23	310.00	800.00

[a] The weighted average was obtained by use of the following formula:

$$\frac{3 \text{ Lecture} + 1 \text{ Laboratory}}{4}$$

Table 3.1

Intercorrelation Matrix of Eight Variables for Total Group of Physics 303K Students Who Took the Physics Achievement Test, Fall 1982 (Maximum N = 580)

Variable	PHY 303K Grade	PHY 103M Grade	PHY 303K, 103M GPA	Wt'd PHY 303K, 103M GPA	Calculus Grade	SAT-M Score	Math I Score	Physics Score
Physics 303K Grade	1.00 (542)	0.45 (539)	0.87 (512)	0.97 (512)	0.64 (396)	0.42 (470)	0.47 (400)	0.42 (542)
Physics 103M Grade	0.45 (539)	1.00 (544)	0.82 (512)	0.63 (512)	0.51 (397)	0.07 (473)	0.14 (402)	0.07 (544)
Physics 303K, 103M Grade Average	0.87 (512)	0.82 (512)	1.00 (512)	0.96 (512)	0.68 (386)	0.31 (449)	0.37 (380)	0.30 (512)
Physics 303K, 103M Weighted Grade Average[a]	0.97 (512)	0.63 (512)	0.96 (512)	1.00 (512)	0.69 (386)	0.38 (449)	0.44 (380)	0.38 (512)
Calculus Grade	0.64 (396)	0.51 (397)	0.69 (386)	0.69 (386)	1.00 (408)	0.32 (373)	0.45 (338)	0.20 (408)
SAT Mathematical Score	0.42 (470)	0.07 (473)	0.31 (449)	0.38 (449)	0.32 (373)	1.00 (495)	0.69 (397)	0.45 (495)
Mathematics Level I Score	0.47 (400)	0.14 (402)	0.37 (380)	0.44 (380)	0.45 (338)	0.69 (397)	1.00 (424)	0.39 (424)
Physics Achievement Score	0.42 (542)	0.07 (544)	0.30 (512)	0.38 (512)	0.20 (408)	0.45 (495)	0.39 (424)	1.00 (580)

[a] The weighted average was obtained by use of the following formula:

$$\frac{3 \text{ Lecture} + 1 \text{ Laboratory}}{4}$$

Table 3.2

Intercorrelation Matrix of Eight Variables for Select Group of Physics 303K Students Who Took the Physics Achievement Test, Fall 1982 (Maximum N = 283)

Variable	PHY 303K Grade	PHY 103M Grade	PHY 303K, 103M GPA	Wt'd PHY 303K, 103M GPA	Calculus Grade	SAT-M Score	Math I Score	Physics Score
Physics 303K Grade	1.00 (283)	0.47 (283)	0.88 (283)	0.98 (283)	0.64 (267)	0.40 (274)	0.45 (283)	0.42 (283)
Physics 103M Grade	0.47 (283)	1.00 (283)	0.83 (283)	0.65 (283)	0.52 (267)	0.08 (274)	0.14 (283)	-0.03 (283)
Physics 303K, 103M Grade Average	0.88 (283)	0.83 (283)	1.00 (283)	0.96 (283)	0.68 (267)	0.29 (274)	0.36 (283)	0.25 (283)
Physics 303K, 103M Weighted Grade Average[a]	0.98 (283)	0.65 (283)	0.96 (283)	1.00 (283)	0.68 (267)	0.36 (274)	0.42 (283)	0.36 (283)
Calculus Grade	0.64 (267)	0.52 (267)	0.68 (267)	0.68 (267)	1.00 (267)	0.33 (259)	0.48 (267)	0.22 (267)
SAT Mathematical Score	0.40 (274)	0.08 (274)	0.29 (274)	0.36 (274)	0.33 (259)	1.00 (274)	0.66 (274)	0.45 (274)
Mathematics Level I Score	0.45 (283)	0.14 (283)	0.36 (283)	0.42 (283)	0.48 (267)	0.66 (274)	1.00 (283)	0.38 (283)
Physics Achievement Score	0.42 (283)	-0.03 (283)	0.25 (283)	0.36 (283)	0.22 (267)	0.45 (274)	0.38 (283)	1.00 (283)

[a] The weighted average was obtained by use of the following formula:

$$\frac{3 \text{ Lecture} + 1 \text{ Laboratory}}{4}$$

coefficient (.45) for the engineering students; for the Mathematics Level I test, the larger group attained a stronger correlation (.47) than did the select group.

For the select group, Tables 4.1-4.4 present descriptive statistics, two frequency distributions of 283 scores on the Physics Achievement test in relation to final course grades in the lecture course (Physics 303K), the accuracy of placement based on each of 10 possible decision scores, and a series of possible decision scores suggested by six guidelines.

In addition to descriptive statistics and its frequency distribution, Table 4.1 provides two sets of expected values derived from the two regression equations shown on the following table. The second column of Table 4.1 lists for each test score its expected (predicted) grade (0-4 scale), while the bottom row of the table reports the Physics test score expected for each letter grade (0-4 scale). Table 4.2 repeats the descriptive statistics from Table 4.1, presents the two regression equations, and collapses the five letter grades into Unsatisfactory (F, D) and Satisfactory (C - A) categories.

Using the numbers from the two categories of Table 4.2, Table 4.3 shows the degree of placement accuracy achieved by each of 10 possible decision scores, first by numbers and percentages within the Unsatisfactory and Satisfactory Performance subgroups and then by numbers and percentages within the total group. Placement accuracy is expressed as placement Too High, Correct (OK), and Too Low. The analysis is based on a comparison of student performance on the Physics test, as measured by the test scores, with student performance in Physics 303K, as measured by the grades assigned by the instructors. With reference to data of Tables 4.1 through 4.3, Table 4.4 then summarizes six possible guidelines suggested by various authorities for selecting a decision score.

In this second study, the mean Physics score received at the beginning of the course by the 283 engineering students was 543.85, with a standard deviation of 77.23; their mean final grade on the 0-4 (F - A) scale was 2.07, with a standard deviation of 1.22. The coefficient of correlation between the test scores and the final grades in Physics 303K was .42. The set of 10 possible decision scores examined in Table 4.3 ranged from 440 to

Table 4.1

Beginning-of-Course Physics Achievement Test Scores in Relation to Performance in Physics 303K: Frequency Distributions, Descriptive Statistics, Expected Grades, and Expected Scores

		Final Course Grades (0-4) in Physics 303K							
Test Scores	Expected Grades	(0) F	(1) D	(2) C	(3) B	(4) A	Total N		
700-800	3.11-3.77			3	2	5	10		
660-690	2.84-3.04		1	1	4	7	13		
650	2.78				2	1	3		
640	2.71	1	2	3	4	2	12		
630	2.64		2	1	3		6		
620	2.58			1		1	2		
610	2.51	1			1	1	3		
600	2.44	2	1	6	4	2	15		
590	2.38			4	3	2	9		
580	2.31	1	5	6	4	3	19		
570	2.24	1		5	1	1	8		
560	2.18	1	6	8	8	1	24		
550	2.11		2	1	4	2	9		
540	2.04	4	5	7	8	2	26		
530	1.98			4	3	1	8		
520	1.91	2	3	3	6	1	15		
510	1.85		1	3	1	1	6		
500	1.78	3	4	14	6		27		
490	1.71	5		4	2		11		
480	1.65	1	2	3	1	1	8		
470	1.58	1		3	1		5		
460	1.51	3	3	5	3		14		
450	1.45	3					3		
440	1.38	2	1	2	3		8		
430	1.31	1	1				2		
420	1.25	3	1				4		
410	1.18	1	1	2			4		
400	1.12	2		1			3		
390	1.05	2					2		
380	0.98	1			1		2		
370	0.92								
360	0.85								
350	0.78	1					1		
340	0.72								
330	0.65								
320	0.58								
310	0.52					1	1		
200-300	(-.21)-(.45)								
Total		42	41	90	75	35	283	Mean Grade	Standard Deviation
%		15%	14%	32%	27%	12%	100%	2.07	1.22
Mean Score		483	536	539	557	613	543.85	Correlation Coefficient r = .42	
Standard Deviation		68	61	63	67	94	77.23		
Expected Score		489	515	542	568	595			

Table 4.2

Beginning-of-Course Physics Achievement Test Scores in Relation to Performance in Physics 303K: Combined Frequency Distributions And Regression Equations

	Preliminary Course Grades		
Test Scores	Unsatisfactory F,D	Satisfactory C-A	Total N
700-800		10	10
660-690	1	12	13
650		3	3
640	3	9	12
630	2	4	6
620		2	2
610	1	2	3
600	3	12	15
590		9	9
580	6	13	19
570	1	7	8
560	7	17	24
550	2	7	9
540	9	17	26
530		8	8
520	5	10	15
510	1	5	6
500	7	20	27
490	5	6	11
480	3	5	8
470	1	4	5
460	6	8	14
450	3		3
440	3	5	8
430	2		2
420	4		4
410	2	2	4
400	2	1	3
390	2		2
380	1	1	2
370			
360			
350	1		1
340			
330			
320			
310		1	1
200-300			
Total	83	200	283
%	29%	71%	100%
Mean Score	509	558	543.85
Standard Deviation	70	75	77.23

Mean Grade	Standard Deviation
2.07	1.22

Correlation Coefficient

r = .42

Equations Used to Obtain Expected Values Shown in Table 4.1

Expected Scores (bottom row)
Expected Grades (second column)

Expected Score =

$$\left(\begin{matrix}\text{Final}\\ \text{Grade}\end{matrix} \times 26.5105\right) + 488.9571$$

Expected Grade =

$$\left(\begin{matrix}\text{Test}\\ \text{Score}\end{matrix} \times .006637\right) - 1.5390$$

Table 4.3

Beginning-of-Course Physics Achievement Test Scores in Relation To Performance in Physics 303K: Possible Decision Scores and Corresponding Accuracies of Placement (N = 283)

	Cumulative Number of Students				Percent of Students in Each Placement Category				Overall Accuracy of Placement		
Placement Category	Unsatis-factory F,D (N=83)		Satis-factory C-A (N=200)		Unsatis-factory F,D		Satis-factory C-A		Accuracy Category	No. of Students	% of Students
540 - up	Too High	35	124	OK	Too High	42%	62%	OK	Too High	35	12%
									Correct	172	61%
Below 540	OK	48	76	Too Low	OK	58%	38%	Too Low	Too Low	76	27%
530 - up	Too High	35	132	OK	Too High	42%	66%	OK	Too High	35	12%
									Correct	180	64%
Below 530	OK	48	68	Too Low	OK	58%	34%	Too Low	Too Low	68	24%
520 - up	Too High	40	142	OK	Too High	48%	71%	OK	Too High	40	14%
									Correct	185	65%
Below 520	OK	43	58	Too Low	OK	52%	29%	Too Low	Too Low	58	21%
510 - up	Too High	41	147	OK	Too High	49%	74%	OK	Too High	41	15%
									Correct	189	67%
Below 510	OK	42	53	Too Low	OK	51%	26%	Too Low	Too Low	53	19%
500 - up	Too High	48	167	OK	Too High	58%	84%	OK	Too High	48	17%
									Correct	202	71%
Below 500	OK	35	33	Too Low	OK	42%	16%	Too Low	Too Low	33	12%
490 - up	Too High	53	173	OK	Too High	64%	86%	OK	Too High	53	19%
									Correct	203	72%
Below 490	OK	30	27	Too Low	OK	36%	14%	Too Low	Too Low	27	10%
480 - up	Too High	56	178	OK	Too High	68%	89%	OK	Too High	56	20%
									Correct	205	72%
Below 480	OK	27	22	Too Low	OK	32%	11%	Too Low	Too Low	22	8%
470 - up	Too High	57	182	OK	Too High	69%	91%	OK	Too High	57	20%
									Correct	208	74%
Below 470	OK	26	18	Too Low	OK	31%	9%	Too Low	Too Low	18	6%
460 - up	Too High	63	190	OK	Too High	76%	95%	OK	Too High	63	22%
									Correct	210	74%
Below 460	OK	20	10	Too Low	OK	24%	5%	Too Low	Too Low	10	4%
440 - up	Too High	69	195	OK	Too High	83%	98%	OK	Too High	69	24%
									Correct	209	74%
Below 440	OK	14	5	Too Low	OK	17%	2%	Too Low	Too Low	5	2%

Table 4.4

Beginning-of-Course Physics Achievement Test Scores in Relation to Performance in Physics 303K: Scores Suggested by Six Guidelines For Use in Selecting Decision Scores (N = 283)

Guideline	Score
1. Expected Score for students whose performance in course was just minimally satisfactory (i.e., students with final grades of C; see Expected Score row at bottom of Table 4.1).	540
2. Score for which Expected Grade was just minimally satisfactory (i.e., C; see Expected Grade column in Table 4.1).	540
3. Score for which percents of placement errors of students in each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal. (See % Too High and % Too Low values in middle columns of Table 4.3.)	540
4. Score for which overall percents of placement errors were most nearly equal. (See % Too High and % Too Low values in last column of Table 4.3.)	510
5. Score that would have cut off (or held back) approximately the same number of students as were in the Unsatisfactory performance group. (See Table 4.2 for number of students in Unsatisfactory group and the test score that most nearly identifies that number of low-scoring students.)	500
6. Score that would have maximized overall accuracy of placement. (See number correct in next-to-last column of Table 4.3.)	440

540. Decision scores suggested by the six guidelines in Table 4.4 also ranged from 440 to 540.

A slightly higher coefficient of correlation (.45) was found for the 283 engineering students between their pre-enrollment scores on the Achievement Test in Mathematics Level I and their final grades in Physics 303K. (See Tables 5.1 and 5.2.) Their mean Mathematics Level I score was 622.44, with a standard deviation of 69.40; the mean lecture course grade was 2.07 with a standard deviation of 1.22. The set of 10 possible decision scores examined in Table 5.3 ranged from 530 to 620. The six guidelines of Table 5.4 suggested the selection of decision scores that also ranged from 530 to 620.

To determine whether or not the use of scores from both Achievement tests in combination would increase the coefficient of correlation with final grades in the course, a multiple regression analysis was performed in which both Physics and Mathematics Level I test scores were combined to predict course grades in Physics 303K. Tables 6.1-6.4 present the results of this additional analysis, in which the best linear composites of the two Achievement test scores (labeled PG4 Scores in Tables 6.1-6.4) were used to obtain expected Physics 303K final grades. The predictive validity coefficient of .52 between the best linear composite of the two test scores (PG4 Scores) and final grades in the course was higher than the correlation coefficient for either the Physics test scores (.42) or the Mathematics Level I test scores (.45) alone. The mean PG4 Score for the 283 engineering students was 2.1, with a standard deviaion of 0.6. The set of 10 possible PG4 decision scores examined in Table 6.3 ranged from 1.5 to 2.4. The six guidelines of Table 6.4 suggested the selection of PG4 decision scores ranging from 1.5 to 2.1.

Discussion

Had the validity coefficient obtained in Study 1 (.34) reached the customary minimum level of .40, MEC staff members would have recommended the use of a decision score of 600 on the Mathematics Level I test for placement purposes. A decision score of 600 would have routed 239 (45%) of the 537 students into a prerequisite course, Physics 306, which was offered for the first time in the spring of 1982. The score of 600 was the

Table 5.1

Beginning-of-Course Mathematics Level I Achievement Test Scores in Relation To Performance in Physics 303K: Frequency Distributions, Descriptive Statistics, Expected Grades, and Expected Scores

		Final Course Grades (0-4) in Physics 303K							
Test Scores	Expected Grades	(0) F	(1) D	(2) C	(3) B	(4) A	Total N		
700-800	2.68-3.47		5	7	19	17	48		
660-690	2.37-2.60	2	6	17	14	2	41		
650	2.29		2	5	3	7	.17		
640	2.21	2	2	5	3		12		
630	2.13	1		7	5	2	15		
620	2.05	4	3	3	6	2	18		
610	1.97	1	2	7	6	1	17		
600	1.89	3	5	8	4		20		
590	1.82	3	4	6	6		19		
580	1.74	2	3	2	1	1	9		
570	1.66	6	4	9	3	1	23		
560	1.58	6	1	3	1		11		
550	1.50	1	1	1	2		5		
540	1.42			1			1		
530	1.34		1	2	1	1	5		
520	1.27	1				1	2		
510	1.19		1	1			2		
500	1.11	2					2		
490	1.03	1		2			3		
480	0.95	1	1	1			3		
470	0.87	1					1		
460	0.79	1		3			4		
450	0.71	2			1		3		
440	0.64								
430	0.56								
420	0.48								
410	0.40	2					2		
400	0.32								
390	0.24								
380	0.16								
370	0.09								
360	0.01								
350	-0.07								
340	-0.15								
330	-0.23								
320	-0.31								
310	-0.39								
200-300	(-1.25)-(-.47)								
Total		42	41	90	75	35	283	Mean Grade	Standard Deviation
%		15%	14%	32%	27%	12%	100%	2.07	1.22
Mean Score		560	618	614	646	673	622.44	Correlation Coefficient r = .45	
Standard Deviation		65	59	61	60	62	69.40		
Expected Score		570	595	621	646	671			

Table 5.2

Beginning-of-Course Mathematics Level I Achievement Test Scores in Relation To Performance in Physics 303K: Combined Frequency Distributions And Regression Equations

	Preliminary Course Grades		
Test Scores	Unsatisfactory F,D	Satisfactory C-A	Total N
700-800	5	43	48
660-690	8	33	41
650	2	15	17
640	4	8	12
630	1	14	15
620	7	11	18
610	3	14	17
600	8	12	20
590	7	12	19
580	5	4	9
570	10	13	23
560	7	4	11
550	2	3	5
540		1	1
530	1	4	5
520	1	1	2
510	1	1	2
500	2		2
490	1	2	3
480	2	1	3
470	1		1
460	1	3	4
450	2	1	3
440			
430			
420			
410	2		2
400			
390			
380			
370			
360			
350			
340			
330			
320			
310			
200-300			
Total	83	200	283
%	29%	71%	100%
Mean Score	589	636	622.44
Standard Deviation	68	65	69.40

Mean Grade	Standard Deviation
2.07	1.22

Correlation Coefficient

r = .45

Equations Used to Obtain Expected Values Shown in Table 5.1

Expected Scores (bottom row)
Expected Grades (second column)

Expected Score =

$$\left(\begin{matrix}\text{Final}\\ \text{Grade}\end{matrix} \times 25.3705\right) + 569.9042$$

Expected Grade =

$$\left(\begin{matrix}\text{Test}\\ \text{Score}\end{matrix} \times .007865\right) - 2.8246$$

Table 5.3

Beginning-of-Course Mathematics Level I Achievement Test Scores in Relation To Performance in Physics 303K: Possible Decision Scores and Corresponding Accuracies of Placement (N = 283)

	Cumulative Number of Students				Percent of Students in Each Placement Category				Overall Accuracy of Placement		
Placement Category	Unsatisfactory F,D (N=83)		Satisfactory C-A (N=200)		Unsatisfactory F,D		Satisfactory C-A		Accuracy Category	No. of Students	% of Students
620 - up	Too High	27	124	OK	Too High	32%	62%	OK	Too High	27	10%
									Correct	180	64%
Below 620	OK	56	76	Too Low	OK	68%	38%	Too Low	Too Low	76	27%
610 - up	Too High	30	138	OK	Too High	36%	69%	OK	Too High	30	11%
									Correct	191	68%
Below 610	OK	53	62	Too Low	OK	64%	31%	Too Low	Too Low	62	22%
600 - up	Too High	38	150	OK	Too High	46%	75%	OK	Too High	38	13%
									Correct	195	69%
Below 600	OK	45	50	Too Low	OK	54%	25%	Too Low	Too Low	50	18%
590 - up	Too High	45	162	OK	Too High	54%	81%	OK	Too High	45	16%
									Correct	200	71%
Below 590	OK	38	38	Too Low	OK	46%	19%	Too Low	Too Low	38	13%
580 - up	Too High	50	166	OK	Too High	60%	83%	OK	Too High	50	18%
									Correct	199	70%
Below 580	OK	33	34	Too Low	OK	40%	17%	Too Low	Too Low	34	12%
570 - up	Too High	60	179	OK	Too High	72%	90%	OK	Too High	60	21%
									Correct	202	71%
Below 570	OK	23	21	Too Low	OK	28%	10%	Too Low	Too Low	21	7%
560 - up	Too High	67	183	OK	Too High	81%	92%	OK	Too High	67	24%
									Correct	199	70%
Below 560	OK	16	17	Too Low	OK	19%	8%	Too Low	Too Low	17	6%
550 - up	Too High	69	186	OK	Too High	83%	93%	OK	Too High	69	25%
									Correct	200	71%
Below 550	OK	14	14	Too Low	OK	17%	7%	Too Low	Too Low	14	5%
540 - up	Too High	69	187	OK	Too High	83%	94%	OK	Too High	69	24%
									Correct	201	71%
Below 540	OK	14	13	Too Low	OK	17%	6%	Too Low	Too Low	13	5%
530 - up	Too High	70	191	OK	Too High	70%	96%	OK	Too High	70	25%
									Correct	204	72%
Below 530	OK	13	9	Too Low	OK	13%	4%	Too Low	Too Low	9	3%

Table 5.4

Beginning-of-Course Mathematics Level I Achievement Test Scores In Relation to Performance in Physics 303K: Scores Suggested By Six Guidelines for Use in Selecting Decision Scores (N = 283)

Guideline	Score
1. Expected Score for students whose performance in course was just minimally satisfactory (i.e., students with final grades of C; see Expected Score row at bottom of Table 5.1).	620
2. Score for which Expected Grade was just minimally satisfactory (i.e., C; see Expected Grade column in Table 5.1).	620
3. Score for which percents of placement errors of students in each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal. (See % Too High and % Too Low values in middle columns of Table 5.3.)	610
4. Score for which overall percents of placement errors were most nearly equal. (See % Too High and % Too Low values in last column of Table 5.3.)	590
5. Score that would have cut off (or held back) approximately the same number of students as were in the Unsatisfactory performance group. (See Table 5.2 for number of students in Unsatisfactory group and the test score that most nearly identifies that number of low-scoring students.)	580
6. Score that would have maximized overall accuracy of placement. (See number correct in next-to-last column of Table 5.3.)	530

Table 6.1

Beginning-of-Course Predicted Grades (PG4 Scores) in Relation to Actual Performance in Physics 303K: Frequency Distributions, Descriptive Statistics, Expected Grades, and Expected PG4s

		Final Course Grades (0-4) in Physics 303K					
PG4 Scores	Expected Grades	(0) F	(1) D	(2) C	(3) B	(4) A	Total N
3.8-4.0	3.8-4.0						
3.7	3.7					1	1
3.6	3.6						
3.5	3.5					1	1
3.4	3.4				2	2	4
3.3	3.3				2	3	5
3.2	3.2			2	2	1	5
3.1	3.1		1	3	3	2	9
3.0	3.0		2	1	2	1	6
2.9	2.9					4	4
2.8	2.8		1	1	3	1	6
2.7	2.7			1	5	2	8
2.6	2.6		3	3	5	3	14
2.5	2.5	1	3	2	6		12
2.4	2.4	1		5	3	3	12
2.3	2.3	2		5	1	4	12
2.2	2.2	2	3	10	7	1	23
2.1	2.1		3	8	3	3	17
2.0	2.0		6	9	6	1	22
1.9	1.9	2	3	7	10		22
1.8	1.8	2	3	10	3		18
1.7	1.7	7	4	4	3	1	19
1.6	1.6	5	3	7	4	1	20
1.5	1.5		1	2	1		4
1.4	1.4	2	2				4
1.3	1.3	2			1		3
1.2	1.2	2	1	4	1		8
1.1	1.1	3	1	1	1		6
1.0	1.0	5		1	1		7
0.9	0.9			3			3
0.8	0.8		1				1
0.7	0.7	2		1			3
0.6	0.6	1					1
0.5	0.5	1					1
0.4	0.4	1					1
0.3	0.3						
0.2	0.2	1					1
0.0-0.1	0.0-0.1						
Total		42	41	90	75	35	283
%		15%	14%	32%	27%	12%	100%
Mean PG4 Score		1.4	2.0	2.0	2.3	2.7	2.1
Standard Deviation		0.6	0.5	0.5	0.6	0.5	0.6
Expected PG4 Score		1.5	1.8	2.1	2.3	2.6	

Mean Grade	Standard Deviation
2.07	1.22

Multiple Correlation Coefficient

R = .52

Table 6.2

Beginning-of-Course Predicted Grades (PG4 Scores) in Relation to Actual Performance in Physics 303K: Combined Frequency Distributions And Regression Equations

	Preliminary Course Grades		
PG4 Scores	Unsatisfactory F,D	Satisfactory C-A	Total N
3.8-4.0			
3.7		1	1
3.6			
3.5		1	1
3.4		4	4
3.3		5	5
3.2		5	5
3.1	1	8	9
3.0	2	4	6
2.9		4	4
2.8	1	5	6
2.7		8	8
2.6	3	11	14
2.5	4	8	12
2.4	1	11	12
2.3	2	10	12
2.2	5	18	23
2.1	3	14	17
2.0	6	16	22
1.9	5	17	22
1.8	5	13	18
1.7	11	8	19
1.6	8	12	20
1.5	1	3	4
1.4	4		4
1.3	2	1	3
1.2	3	5	8
1.1	4	2	6
1.0	5	2	7
0.9		3	3
0.8	1		1
0.7	2	1	3
0.6	1		1
0.5	1		1
0.4	1		1
0.3			
0.2	1		1
0.0-0.1			
Total	83	200	283
%	29%	71%	100%
Mean PG4 Score	1.7	2.2	2.1
Standard Deviation	0.6	0.6	0.6

Equations Used to Obtain Expected Values Shown in Table 6.1

Expected Scores (bottom row)
Expected Grades (second column)

Expected PG4 Score =

$$\left(\text{Final Grade} \times 0.2716\right) + 1.5073$$

Expected Grade =

(Mathematics Score x .0059) + (Physics Score x .0046) - 4.1043

Mean Grade	Standard Deviation
2.07	1.22

Multiple Correlation Coefficient

R = .52

Table 6.3

Beginning-of-Course Predicted Grades (PG4 Scores) in Relation to Actual Performance in Physics 303K: Possible Decision PG4 Scores And Corresponding Accuracies of Placement (N = 283)

	Cumulative Number of Students				Percent of Students in Each Placement Category				Overall Accuracy of Placement		
Placement Category	Unsatis-factory F,D (N=83)		Satis-factory C-A (N=200)		Unsatis-factory F,D		Satis-factory C-A		Accuracy Category	No. of Students	% of Students
2.4 - up	Too High	12	75	OK	Too High	14%	38%	OK	Too High	12	4%
									Correct	146	52%
Below 2.4	OK	71	125	Too Low	OK	86%	62%	Too Low	Too Low	125	44%
2.3 - up	Too High	14	85	OK	Too High	17%	42%	OK	Too High	14	5%
									Correct	154	54%
Below 2.3	OK	69	115	Too Low	OK	83%	58%	Too Low	Too Low	115	41%
2.2 - up	Too High	19	103	OK	Too High	23%	52%	OK	Too High	19	8%
									Correct	167	59%
Below 2.2	OK	64	97	Too Low	OK	77%	48%	Too Low	Too Low	97	34%
2.1 - up	Too High	22	117	OK	Too High	26%	58%	OK	Too High	22	8%
									Correct	178	63%
Below 2.1	OK	61	83	Too Low	OK	74%	42%	Too Low	Too Low	83	29%
2.0 - up	Too High	28	133	OK	Too High	34%	66%	OK	Too High	28	10%
									Correct	188	66%
Below 2.0	OK	55	67	Too Low	OK	66%	34%	Too Low	Too Low	67	24%
1.9 - up	Too High	33	150	OK	Too High	40%	75%	OK	Too High	33	12%
									Correct	200	71%
Below 1.9	OK	50	50	Too Low	OK	60%	25%	Too Low	Too Low	50	18%
1.8 - up	Too High	38	163	OK	Too High	46%	82%	OK	Too High	38	13%
									Correct	208	74%
Below 1.8	OK	45	37	Too Low	OK	54%	18%	Too Low	Too Low	37	13%
1.7 - up	Too High	49	171	OK	Too High	59%	86%	OK	Too High	49	17%
									Correct	205	72%
Below 1.7	OK	34	29	Too Low	OK	41%	14%	Too Low	Too Low	29	10%
1.6 - up	Too High	57	183	OK	Too High	69%	92%	OK	Too High	57	20%
									Correct	209	74%
Below 1.6	OK	26	17	Too Low	OK	31%	8%	Too Low	Too Low	17	6%
1.5 - up	Too High	58	186	OK	Too High	70%	93%	OK	Too High	58	21%
									Correct	211	75%
Below 1.5	OK	25	14	Too Low	OK	30%	7%	Too Low	Too Low	14	5%

Table 6.4

Beginning-of-Course Predicted Grades (PG4 Scores) in Relation to Actual Performance in Physics 303K: PG4 Scores Suggested by Six Guidelines For Use in Selecting Decision Scores
(N = 283)

Guideline	Predicted Grade (PG4 Score)
1. Expected PG4 Score for students whose performance in course was just minimally satisfactory (i.e., students with final grades of C; see Expected PG4 Score row at Table 6.1.)	2.1
2. PG4 Score for which Expected Grade was just minimally satisfactory (i.e., C; see Expected Grade column in Table 6.1).	2.0
3. PG4 Score for which percents of placement errors of students in each academic performance category (Unsatisfactory, Satisfactory) were most nearly equal. (See % Too High and % Too Low values in middle columns of Table 6.3.)	2.0
4. PG4 Score for which overall percents of placement errors were most nearly equal. (See % Too High and % Too Low values in last column of Table 6.3.)	1.8
5. PG4 Score that would have cut off (or held back) approximately the same number of students as were in the Unsatisfactory performance group. (See Table 6.2 for number of students in Unsatisfactory group and the PG4 score that most nearly identifies that number of low-scoring students.)	1.8
6. PG4 Score that would have maximized overall accuracy of placement. (See number correct in next-to-last column of Table 6.3.)	1.5

Mathematics Level I score expected for students whose subsequent performance in Physics 303K was only minimally satisfactory (that is, students who received grades of C); it was also the score at which the percentages within the Unsatisfactory and Satisfactory groups of inaccurately placed students (that is, students placed too high and students placed too low) were about equal. (See Tables 1.1-1.4.)

In the second study, the Mathematics Level I decision score suggested by the first two guidelines of Table 5.4 was 620, while the percentages of inaccurate placement within the two academic performance categories were most nearly equal at the score of 610. It should be noted that the 537 students in Study 1 included non-engineers as well as engineering students, while the 283 students of Study 2 were selected for analysis precisely because they were engineering students for whom the relevant data were available. As indicated by comparison of the data in Tables 2.1 and 2.2, the select group was on the whole better prepared to study engineering physics at U.T. Austin than was the larger group.

On the Achievement Test in Physics, the 283 engineering students made lower scores than they did on the Mathematics Level I test. Their mean scores were 544 on the Physics test and 622 on the Mathematics Level I test. The Physics score recommended by the first three guidelines of Table 4.4 was 540 in contrast to the score of 620 that might be recommended on the Mathematics Level I test (see Table 5.4). The validity coefficients for the two tests were .42 for the Physics test and .45 for the Mathematics Level I test.

When scores from these two tests were combined to obtain a weighted composite predictor score (PG4), the validity coefficient between student performances on the tests and in the lecture course rose to .53. While this latter degree of correlation is well within the usual limits for placement studies, none of the results of Study 2 persuaded faculty members in the Department of Physics that they were ready to select a decision score on either test or on both tests combined.

At any decision score suggested by the guidelines of Tables 4.4, 5.4, and 6.4, the percentages of errors in placement Too Low appeared to them to place into a prerequisite course (Physics 306) too many students who might

have been able to succeed in Physics 303K. Although they were reluctant to choose a decision score that might detour into Physics 306 a large number of students who could succeed in Physics 303K despite their low test scores, the faculty members continued to be concerned about the high dropout and failure rates in Physics 303K.

It was in this context that they expressed to MEC staff members their interest in seeing the impact of the new introductory course, Physics 306, on the subsequent performance of its students in Physics 303K. This concern led to Study 3, which follows.

Study 3

Method

Subjects. Two groups of engineering students were used (a) to investigate whether or not Physics 306 helps overcome weak academic preparation in high school mathematics and (b) to determine score intervals on the College Bound Achievement Test in Mathematics Level I test that could be used to advise engineering students whether or not to take Physics 306 prior to taking the required Physics 303K.

The special group of engineering students who took Physics 303K in the fall of 1982 and served as subjects in Study 2 comprised one of the two groups of students used in Study 3. That special group of Physics 303K students in Study 2 consisted of engineering students who (a) had taken no college physics courses prior to their enrollment in Physics 303K, (b) had enrolled in Physics 303K for the first time, (c) were also enrolled in the laboratory course (Physics 103M), (d) had prior credit for or concurrent enrollment in Mathematics 808A, 608EA, or 608EB, (e) had taken the Mathematics Level I test, and (f) had received a letter grade (F - A) in Physics 303K. Of the 580 students in Physics 303K who took the Physics Achievement Test in the fall of 1982, 283 qualified for inclusion in the Physics 303K special group in Study 2.

The second group of students in Study 3 consisted of engineering students who took the two-course sequence of Physics 306 followed by Physics 303K and who also met requirements (b) through (f) of the special group of

Physics 303K students. The only difference in the requirements for inclusion in the two groups was that the engineering students in the second group had taken no college physics courses prior to enrollment in Physics 306 rather than prior to enrollment in Physics 303K. Of the 423 students who took Physics 306 in either the spring or fall of 1982 prior to enrollment in Physics 303K, 134 qualified for inclusion in the Physics 306-303K special group.

Procedure. Unlike Study 2, for Study 3 it was not necessary to administer the Mathematics Level I test at the beginning of their first physics course to the 134 students in the Physics 306-303K group. This was due to the fact that most students entering U.T. Austin take the Mathematics Level I test for placement in mathematics courses; consequently, the necessary data (Mathematics Level I test scores and Physics 303K grades) were available directly from University data files during the summer of 1983. The necessary data for the Physics 303K group were already available from Study 2.

In order to address the two purposes of Study 3, two separate regression analyses were conducted separately for each group of students. The Mathematics Level I scores were used to predict grades in Physics 303K. Each regression analysis yielded a correlation (validity) coefficient (r) and a regression (prediction) equation. The validity coefficient indicates the correlation or degree of linear relationship between the Mathematics Level I scores and the grades in Physics 303K. The regression equation enables one to predict the grade in Physics 303K that could be expected of students with a given Mathematics Level I score.

Once the expected Physics 303K grades were calculated from the Mathematics Level I scores by use of the two regression equations (one for each group of students), the Johnson-Neyman technique was employed to determine the Mathematics Level I scores that were associated with significant differences between the expected grades for the two groups. That is, the Johnson-Neyman technique revealed the score intervals on the Mathematics Level I test that could be used to advise engineering students whether to take Physics 303K or Physics 306 as their first college-level physics course.

Results and Discussion

Table 7 presents descriptive statistics for the Mathematics Level I scores and Physics 303K grades for each of the two groups. The descriptive statistics include the means and standard deviations of the test scores and grades.

The mean of the Mathematics Level I scores for the Physics 303K group (622.44) was higher than the mean of the test scores for the Physics 306-303K group (544.93). This is not surprising, given the fact that the Mathematics Level I test scores were used indirectly to advise students whether or not they should take Physics 306 prior to taking Physics 303K; that is, one of the prerequisites for Physics 303K was that the students have prior credit for, or concurrent enrollment in, Mathematics 808A, and to be eligible for Mathematics 808A, students must have received a score of 560 or higher on the Mathematics Level I test or a grade of at least C in Mathematics 304E (Trigonometry). Inspection of Table 7 also reveals that the Mathematics Level I scores were slightly more variable for the Physics 303K group (S.D. = 69.40) than were the test scores for the Physics 306-303K group (S.D. = 67.94).

Table 7

Descriptive Statistics for Students in Each of Two Course Sequence Groups: Scores on the Mathematics Level I Achievement Test and Course Grades in Physics 303K

Course Sequence	N	Mathematics Level I Scores		Physics 303K Grades	
		Mean	Standard Deviation	Mean	Standard Deviation
Physics 306-303K	134	544.93	67.94	2.16	1.14
Physics 303K	283	622.44	69.40	2.07	1.22

The mean Physics 303K grades presented in Table 7 show that the Physics 306-303K group had a higher mean grade (2.16) than did the Physics 303K group (2.07). This is an indication that the Physics 306 course had helped overcome the weak preparation in high school mathematics of the students who took Physics 306 prior to taking Physics 303K. The grades were slightly more variable for the Physics 303K group (S.D. = 1.22) than the grades for the Physics 306-303K group (S.D. = 1.14).

Table 8 presents the validity coefficients and the regression equations that were obtained from the regression analyses. The validity coefficient obtained for the Physics 303K group was .45; it indicates that students who received high scores on the Mathematics Level I test tended to perform well in Physics 303K, while students who received low test scores tended to perform poorly in Physics 303K. The validity coefficient of .45 may be considered high enough to justify the use of Mathematics Level I test scores to predict the success of students in Physics 303K.

The validity coefficient of .17 that was obtained for the two-course sequence group was quite low; it indicates that there was only a weak relationship between the Mathematics Level I test scores prior to taking Physics 306 and the grades students received when they later took Physics 303K. This weak relationship or low validity coefficient would be expected if,

Table 8

Results of Regression Analysis for Each of the Course Sequence Groups: Regression Equations and Coefficients of Correlation Between Mathematics Level I Test Scores and Course Grades in Physics 303K

Course Sequence	Regression Equation	Coefficient of Correlation
Physics 306-303K	Expected Grade in PHY 303K = (Math I score x .0029) + .5828	.17
Physics 303K	Expected Grade in PHY 303K = (Math I score x .0079) - 2.8246	.45

in fact, Physics 306 did help overcome the weak preparation in mathematics reflected by low scores on the Mathematics Level I test. That is, one would expect the Mathematics Level I test scores to be unrelated to the Physics 303K grades if Physics 306 rectified the weak preparation in mathematics that causes some students to perform poorly in Physics 303K. Thus, the low validity coefficient of .17 indicates that students with entrance deficiencies in physics and/or in mathematics should take Physics 306 prior to Physics 303K.

The two regression equations presented in Table 8 were used to calculate the expected grades for students in each of the two course sequence groups. The regression lines shown in Figure 1 graphically depict the expected grades obtained for each of the groups. As can be seen from Figure 1, the regression lines intersect at a Mathematics Level I score of approximately 680. For students with Mathematics Level I scores below 680 (the point of intersection), the regression lines indicate that students in the Physics 306-303K group are expected to receive higher Physics 303K grades than students in the Physics 303K group. Conversely, for students with Mathematics Level I scores above 680, students in the Physics 303K group are expected to receive higher grades in Physics 303K than students in the Physics 306-303K group.

In order to determine the Mathematics Level I scores that correspond to statistically significant differences between the expected Physics 303K grades for the two groups, the Johnson-Neyman technique was employed. This analytical technique revealed that the exact point of intersection of the two regression lines was 684.71 and that, for Mathematics Level I scores lower than 603.35, there was a statistically significant difference between the expected Physics 303K grades for the two groups; that is, students with Mathematics Level I scores lower than 603.35 can, with reasonable confidence, be expected to perform better in Physics 303K if they take the two-course sequence than if they enroll directly in Physics 303K.

In addition, the analysis revealed that for students with Mathematics Level I scores higher than 684.71, the differences in the expected grades for the two groups were not statistically significant. Thus, the expected grades for students in the two course sequence groups were significantly

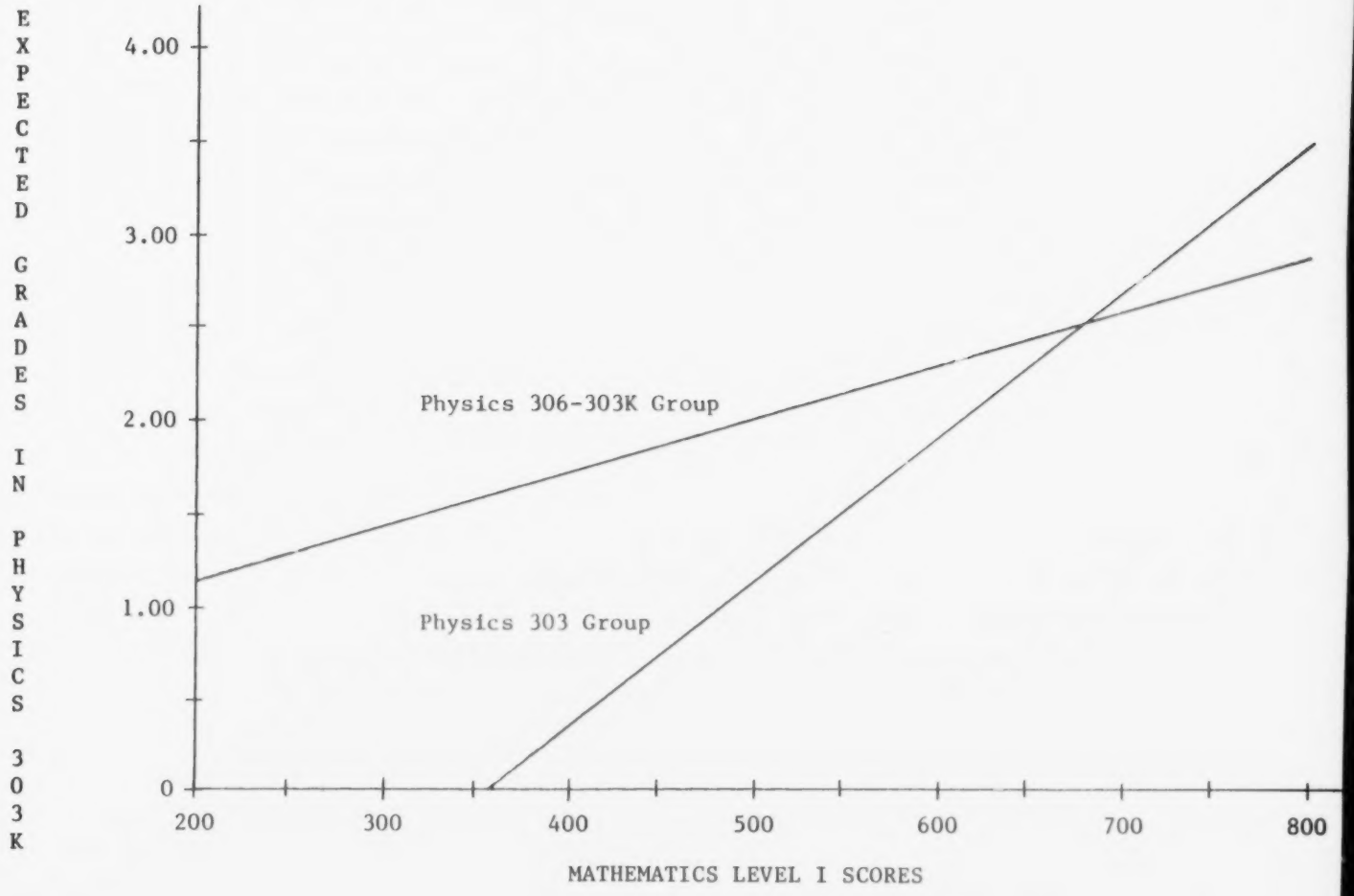


Figure 1. Regression lines for each of the course sequence groups

different only for Mathematics Level I scores lower than 603.35--for practical purposes, 600 or lower.

Based on the results of the Johnson-Neyman analysis, the Mathematics Level I scores were divided into three intervals that could be used to advise engineering students whether or not Physics 306 should be taken prior to taking Physics 303K. The first interval included Mathematics Level I scores of 200-600, because the differences in the expected Physics 303K grades for the two groups were significant for Mathematics Level I scores lower than 603.35. Students with Mathematics Level I scores that are in this interval should be advised to take Physics 306 prior to taking Physics 303K because students with mathematics skills at that level who have taken Physics 306 are expected to receive higher grades in Physics 303K than students who have not taken Physics 306.

The second Mathematics Level I score interval includes test scores of 610-680 because the point of intersection of the two regression lines was 684.71. While students in Study 3 with Mathematics Level I scores within this score interval were expected to receive higher grades in Physics 303K if they had taken the two-course sequence rather than enrolling directly in Physics 303K, such students probably should be permitted to choose whether or not to take Physics 306 prior to taking Physics 303K because the Johnson-Neyman technique failed to find statistically significant differences between the expected Physics 303K grades for the two groups. For advising purposes, the proximity of the students' Mathematics Level I score to the lower and upper limits of this score interval should be taken into consideration when advising a student whether or not to take Physics 306 prior to Physics 303K--that is, if a student's Mathematics Level I score was closer to 610 than 680, he/she should perhaps be advised to take Physics 306 prior to Physics 303K, while a student with a Mathematics Level I score closer to 680 should perhaps be advised to take Physics 303K as his/her first physics course.

The third Mathematics Level I score interval includes test scores that range from 690 to 800 because, unlike the other two intervals, students in the Physics 303K group could be expected to receive equal or higher grades in Physics 303K than the students in the Physics 306-303K group, even though the Johnson-Neyman technique revealed that the differences in the expected

grades for this score interval were not statistically significant. Given the direction of the expected grade differences and the fact that the differences were nonsignificant, students whose Mathematics Level I scores are in this interval should be advised to take Physics 303K as their first physics course.

While the Johnson-Neyman technique yielded information concerning the significant differences between the expected grades for the two groups and the two Mathematics Level I scores that divided the test scores into three intervals, the technique did not indicate how the students in each score interval for each course sequence actually performed in Physics 303K. Consequently, the students in each course sequence group were assigned to the appropriate Mathematics Level I score interval in order to inspect the relationship between the recommended score intervals and the students' actual performances (letter grades) in Physics 303K. The grades of the students in each score interval for each course sequence then were collapsed into two categories, Unsatisfactory (grades of F and D) and Satisfactory (grades of C, B, and A) performance in Physics 303K. Table 9 presents the number and percentages of students in the Unsatisfactory and Satisfactory grade classifications for each score interval within each course sequence.

The numbers in parentheses in the set of columns labeled "Physics 303K Grades" are the percentages of students in a given score interval for a particular course sequence who received unsatisfactory grades and satisfactory grades in Physics 303K, respectively. For example, 25% (N = 28) of the 111 students in the two-course sequence who earned Mathematics Level I scores lower than or equal to 600 received unsatisfactory grades (F,D) in Physics 303K, while 75% (N = 83) of the students in the two-course sequence who earned Mathematics Level I scores lower than or equal to 600 received satisfactory grades (C-A) in Physics 303K.

Each number in parentheses in the column labeled "Total" is the percentage of students in the two course sequences whose test scores placed them in one of the three Mathematics Level I score intervals. For instance, 83% (N = 111) of the 134 students in the Physics 306-303K group had received Mathematics Level I scores lower than or equal to 600.

Table 9

Relationship Between Mathematics Level I Test Score Intervals And Actual Physics 303K Grades for Each of the Two Course Sequence Groups, Physics 306-303K and Physics 303K

Course Sequence	Score Interval	Physics 303K Grades		Total
		D,F	C-A	
Physics 306-303K	690-800	1 (33%)	2 (67%)	3 (2%)
	610-680	5 (25%)	15 (75%)	20 (15%)
	200-600	28 (25%)	83 (75%)	111 (83%)
Physics 303K	690-800	6 (11%)	51 (89%)	57 (20%)
	610-680	24 (22%)	87 (78%)	111 (39%)
	200-600	53 (46%)	62 (54%)	115 (41%)

Table 9 makes it possible to compare the percentage of students who were in each score interval for each of the course sequence groups; these data enable one to assess the relationship between the score intervals and the students' actual performances in Physics 303K. For the 200-600 score interval, a comparison of the percentages of students who earned satisfactory grades in Physics 303K for each of the course sequence groups reveals that 75% of the students in the two-course sequence group received satisfactory grades in Physics 303K, while 54% of the corresponding students who took only Physics 303K received satisfactory grades.

For the 610-680 score interval on the Mathematics Level I test, a slightly higher percentage of the students in the Physics 303K group (78%)

received satisfactory grades in Physics 303K than did the corresponding students in the Physics 306-303K group (75%). These two percentages are so nearly the same that it appears that students with Mathematics Level I scores in this interval performed about equally well in Physics 303K regardless of which course sequence they took.

For the highest Mathematics Level I score interval (690-800), a considerably higher percentage of the students in the Physics 303K group received satisfactory grades in Physics 303K (89%) than did students in the comparable Physics 306-303K group (67%). However, a comparison of these percentages for the 690-800 score interval should be made with caution because there were only three students in the two-course sequence group in this score interval.

In general, the findings of the percentage analyses of the actual grades reveals the same conclusions that were drawn from the results of the Johnson-Neyman analysis--that is, engineering students with Mathematics Level I scores lower than or equal to 600 should be required (or very strongly advised to take Physics 306 prior to enrollment in the required Physics 303K course; engineering students with Mathematics Level I scores in the 610-680 score interval should be allowed to select whichever course sequence they believe would better serve their needs; engineering students with Mathematics Level I scores higher than 680 should be advised to enroll in Physics 303K as their first physics course.

Recommendations and Decisions

In a February, 1984, meeting with representatives of the Department of Physics, MEC staff members reported that the introductory course (Physics 306) appeared to be fulfilling its functions well, according to the results of Study 3.

One indication of its success is given by the coefficients of correlation shown in Table 8. The moderately high coefficient (.45) for the two-course sequence group and the low coefficient (.17) for the one-course group for the relationship between the students' Mathematics Level I test scores and their final course grades in Physics 303K indicates that Physics 306 does, in fact, appear to be reducing the effects of weak preparation in

mathematics. A second indication of its effect on Physics 303K performance is to be found in Table 9, which shows that 75% of the students whose test scores were in the 200-600 range and who took Physics 306 before taking Physics 303K made satisfactory grades (C-A) in Physics 303K, compared to 54% of the students who had similar Mathematics Level I test scores and who took only Physics 303K. Thus, enrollment in Physics 306 prior to Physics 303K appeared to have saved 21% of the low scoring students from failure in Physics 303K.

On the basis of the results from all three studies, MEC staff members first recommended that scores on the Mathematics Level I test be used for placement of low-scoring engineering students to Physics 306 or 303K and that the following set of scores be used for placement decisions:

Test Scores	Placement
200-600	Student to be required (or strongly advised) to enroll in Physics 306 before enrolling in Physics 303K.
610-680	Student to be advised to make his/her own enrollment decision.
690-800	Student to be advised to enroll in Physics 303K.

However, because a score of 600 on the Mathematics Level I test is the minimum score required to earn credit by exmination in Mathematics 305G with a grade of B, MEC staff members modified the first two recommended score intervals to 200-590 and 600-680. Percentages virtually identical to those shown in Table 9 were obtained in an MEC re-analysis of the data, which used score ranges of 200-590, 600-680, and 690-800. (See Table 10.)

After discussion of various alternatives, as well as how and by whom they should be implemented, the departmental representatives shared results of the study with faculty members in the College of Engineering and urged them to advise all incoming engineering freshmen who score below 600 on the Mathematics Level I test to register for Physics 306. In addition, after consultation with the College of Engineering, the Department of Physics

decided to offer Physics 306 during the second as well as the first summer term of 1984; this course was added to the 1983 summer course schedule in order to allow students less well prepared in mathematics another opportunity to improve their skills and to increase their chances of succeeding in the engineering curriculum without a delay in the scheduling of their courses (see Appendix C).

Table 10

Relationship Between Mathematics Level I Test Score Intervals And Actual Physics 303K Grades for Each of the Two Course Sequences: Re-analysis Using Modified Score Ranges

Course Sequence	Score Interval	Physics 303K Grades		Total
		D,F	C-A	
Physics 306-303K	690-800	1 (33%)	2 (67%)	3 (2%)
	600-680	7 (24%)	22 (76%)	29 (22%)
	200-590	30 (29%)	72 (71%)	102 (76%)
Physics 303K	690-800	6 (10%)	51 (90%)	57 (20%)
	600-680	32 (24%)	99 (76%)	131 (46%)
	200-590	45 (47%)	50 (53%)	95 (34%)

APPENDICES

Appendix A: Placement and Credit by Examination Handout, with Test Descriptions and Sample Questions for
College Board Achievement Test in Physics
College Board Achievement Test in Mathematics Level I

Appendix B: Questions About Prior Study of Physics Group Profiles: Tables A and B

Appendix C: Decisions of Department of Physics Regarding Physics 306

APPENDIX A

Placement and Credit by Examination Handout, with Test Descriptions and Sample Questions for

College Board Achievement Test in Physics

College Board Achievement Test in Mathematics Level I

The University of Texas at Austin
MEASUREMENT AND EVALUATION CENTER
2616 Wichita Street, P.O. Box 7246, Austin, Texas 78712
(512)-471-3032

PLACEMENT AND CREDIT BY EXAMINATION IN PHYSICS

Based on the College Board Achievement Test in Physics

Summer Session 1980 through Spring Semester 1981

U.T. Austin provides students with the opportunity to earn course credit by examination. Such credit will satisfy degree requirements in the same way as credit earned by passing a course, except that it will not count as credit earned in residence. Although tests may be taken by prospective students, course credit earned on the basis of test performance will be awarded only to currently or previously enrolled U.T. Austin students. Unsuccessful attempts to earn credit by examination will not become part of a student's official academic record.

Eligibility for Credit by Examination

A student is eligible for credit in any physics course cited in this brochure if he/she earns a satisfactory test score as indicated in the following paragraphs and if he/she does not already have a passing or failing grade in the course or courses—or in the case of transfer students, in an equivalent course or courses—for which credit has been assigned.

COLLEGE BOARD ACHIEVEMENT TEST IN PHYSICS (Physics Achievement Test)
Credit for Physics 302K, 102M, 302L, 102N

The College Board Achievement Test in Physics may be taken either (1) in a College Board-established test center on a nation-wide testing date or (2) on the U.T. Austin campus on a date set by U.T. Austin.

U.T. Austin regularly offers the College Board Achievement Test in Physics for students and prospective students several days before registration for the Fall and Spring Semesters and the first Summer Session.

Test scores from U.T. Austin test administrations are available within several days after the test date, in most cases before a student's assigned registration time. The specific time and place will be announced at the test administration.

The test fee for each Achievement Test is $11.00 (subject to change). No advance reservation is required. The test fee is paid before the actual test time at the location and times listed in the test schedule for a particular testing period. Ordinarily the fee can be paid on the day of the test. Students with a significant degree of documented financial need are eligible for waiver of a reasonable number of test fees (contact Office of Student Financial Aid). It is necessary to present fee waivers at place of fee payment in order to receive a testing room assignment.

A U.T. Austin test schedule will be available at least one month prior to the beginning of each semester or Summer Session.

Requirements for Taking the College Board Achievement Test in Physics on the U.T. Austin Campus

1. You must not have taken the test previously on the U.T. Austin campus. (You may take the test once on campus regardless of whether or not you have taken it before in nation-wide administrations.)
2. You must pay the test fee at a designated location prior to the test time.
3. You must present at the test room a single form of IDENTIFICATION that includes BOTH SIGNATURE and a RECOGNIZABLE PHOTOGRAPH. Without such identification, you will be admitted only if you submit a recognizable photograph of yourself, which will not be returned to you.
4. You must also take with you to the test center several sharpened No. 2 pencils; all other test materials will be provided.

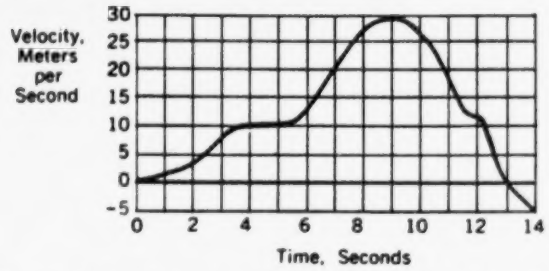
Description and Sample Questions for the College Board Achievement Test in Physics

The Physics Test is designed to measure student achievement in those aspects of physics that are stressed in good high school physics courses regardless of differences in approach in the various courses. The available evidence shows that this goal has been met. Emphasis is on the use of the major principles of physics, often in somewhat unfamiliar situations. The questions are distributed approximately as follows among the major areas of physics: mechanics, 40 percent, electricity and magnetism, 20 percent; optics and waves, 20 percent; atomic and nuclear physics, 10 percent; and heat and kinetic theory, 10 percent.

The following questions are typical of those on the College Board Achievement Test in Physics.

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one which is best in each case.

Questions 1-2



The graph above shows the velocity of a car as a function of time while the car moves along a straight track.

1. **During the 7th second, the car is moving with constant**
   (A) speed (B) velocity (C) acceleration
   (D) momentum (E) kinetic energy

2. **During the first 3 seconds, the car has an average acceleration of about**
   (A) $-\frac{8}{3}$ m/sec² (B) $-\frac{4}{3}$ m/sec² (C) 0 m/sec²
   (D) $\frac{4}{3}$ m/sec² (E) $\frac{8}{3}$ m/sec²

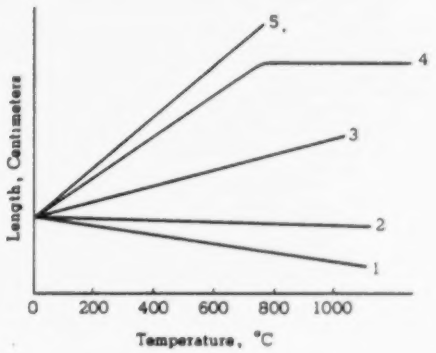
3. **A student places a standard 10-gram mass, which he knows to be accurate, on the right-hand pan of a balance and a mass marked 10 on the left-hand pan. The right-hand pan moves downward and stays down. He can conclude which of the following?**
   I. The two arms of the balance are not of equal length.
   II. The mass marked 10 has a mass greater than 10 grams.
   III. The mass marked 10 has a mass less than 10 grams.
   (A) I only (B) II only (C) III only (D) I and II only
   (E) None of the above statements can be concluded.

4. **One could most accurately determine the acceleration due to gravity g from the formula $g = 2d/t^2$, where d is distance and t is time, by measuring the time for a**
   (A) ping-pong ball to fall a distance of 1 ft.
   (B) steel ball to fall a distance of 1 ft.
   (C) ping-pong ball to fall a distance of 30 ft.
   (D) steel ball to fall a distance of 30 ft.
   (E) pendulum bob to swing a distance of 1 ft. in its arc

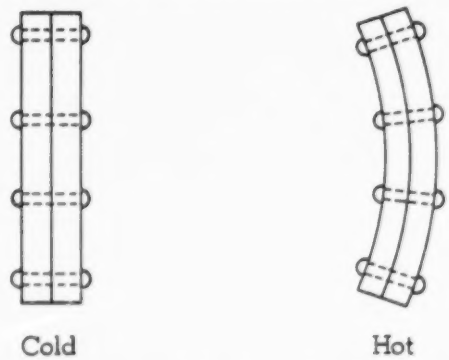
5. **If an electron is projected horizontally into a uniform vertical electric field in a vacuum, the path the electron follows will be**
   (A) a hyperbola (B) a parabola (C) a circle
   (D) a straight line (E) an ellipse

6. **The force of repulsion between two charged spheres, separated by a distance R, is F. If the charge on each sphere were doubled, what separation would give the same repulsive force F?**
   (A) $\frac{1}{4}$R (B) $\frac{1}{2}$R (C) R (D) 2R (E) 4R

7. **The fundamental property that differentiates longitudinal waves from transverse waves is the**
   (A) direction of particle displacement relative to that of wave travel
   (B) speed of the waves
   (C) frequency of the waves
   (D) wavelength of the waves
   (E) density of the medium in which the waves travel



8. **Linear specimens of five different materials, each of the same length at 0° C, are heated slowly; the effects of temperature upon lengths are shown in the graph above.**



When riveted together side by side to form a thermostat actuating element, which combination of two materials would cause the element to curve as shown, when the temperature is increased?
(A) 2 on the left, 1 on the right
(B) 3 on the left, 1 on the right
(C) 3 on the left, 5 on the right
(D) 4 on the left, 2 on the right
(E) 5 on the left, 4 on the right

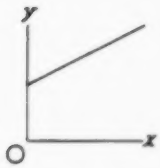
9. **All of the following could be used to detect radioactivity EXCEPT**
   (A) a photographic film (B) an electroscope
   (C) a cloud chamber (D) a scintillation counter
   (E) a cyclotron

10. **A radioactive element has a half-life of 3 days. If a sample initially contains M grams of the element, after 12 days it will contain**
    (A) M/16 grams (B) M/12 grams (C) M/8 grams
    (D) M/4 grams (E) M/2 grams

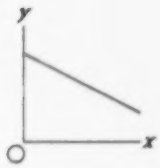
Questions 11-12

Directions: The group of questions below relates to five graphs each showing a quantity y plotted as a function of another quantity x. For each question, choose the graph that gives the correct relationship between the indicated quantities. Each graph may be used once, more than once, or not at all.

(A)



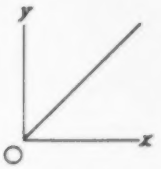
(B)



(C)

(D)

(E)



	y	x
11.	The current through a resistor whose resistance is held constant	The potential difference across the resistor
12.	Wavelength of a radio wave	Frequency of the wave

Directions: For the question below, ONE or MORE of the responses given are correct. Decide which of the responses is (are) correct. Then choose

A If 1, 2, and 3 are correct;
B If only 1 and 2 are correct;
C If only 2 and 3 are correct;
D If only 1 is correct;
E If only 3 is correct.

Directions Summarized

(A)	(B)	(C)	(D)	(E)
1, 2, 3	1, 2 only	2, 3 only	1 only	3 only

13. For which of the following reasons does the pressure of a gas increase when the gas is heated in a closed container at constant volume?

(1) The average change in momentum per gas molecule hitting the walls of the container increases.
(2) The number of gas molecules hitting the walls per time period increases.
(3) The gas molecules increase in size although their speed remains constant.

Answers to Sample Questions

1. C 2. E 3. E 4. D 5. B 6. D 7. A 8. C 9. E 10. A
11. E 12. D 13. B

Level of Performance for Placement and Credit

Scores	Credit			
	PHY 302K,	102M,	302L,	102N
700-800	A	A	A	A
640-699	B	B	B	B
580-639	C	C	C	C

Persons who already have credit for one or more courses in the Physics 302K, 102M, 302L, 102N sequence can earn credit for the other course(s) by examination.

CLAIMING CREDIT: PETITION FORM

NO CREDIT WILL BE REPORTED TO THE REGISTRAR UNTIL – AND UNLESS – YOU COMPLETE AND RETURN A PETITION FORM TO THE MEASUREMENT AND EVALUATION CENTER.

THE UNIVERSITY OF TEXAS AT AUSTIN
MEASUREMENT AND EVALUATION CENTER
AUSTIN, TEXAS 78712-7246

Box 7246
(512) 471-3032

SATISFACTORY SCORES FOR ACHIEVEMENT TESTS
TAKEN IN COLLEGE BOARD CENTERS DURING OR AFTER MAY, 1980

CB ACHIEVEMENT TESTS USED BY U.T. AUSTIN

This table replaces the information in the attached pamphlet or chart. The differences do not represent any change in the standards of performance required by U.T. Austin. They result from an adjustment growing out of certain technical aspects of test construction.

Examination	Scores	U.T. Austin Courses/Grades
English Composition	610–800	E 306, A
	550–609	E 306, B
Mathematics Level I (and also Level II)	670–800	M 305G, A
	600–669	M 305G, B
	560–599	M 305G, C
	Below 560, scores are used for placement, though not for credit.	

Examination	Scores	PHY 302K,	102M,	302L,	102N
Physics	690–800	A	A	A	A
	630–689	B	B	B	B
	570–629	C	C	C	C

With scores from tests taken in CB centers before May, 1980, a different table, available from MEC, should be used.

11/82

The University of Texas at Austin
Measurement and Evaluation Center
2616 Wichita Street, Box 7246
Austin, TX 78712, (512) 471-3032

Placement and Credit by Examination in Mathematics*

Academic policies cover the period Summer Session 1982 through Spring Semester 1983.

The College Board Achievement Test in Mathematics Level I (Math Level I Test) is required of most students before they can register for any lower-division course taught in the Department of Mathematics. The test score is used both to advise students about courses they should take and to help them determine which courses they will be allowed to take. Although Math Level I is the required test, students may present, instead, a score on the College Board Achievement Test in Mathematics Level II.

Also, the Math Level I (or Level II) Test serves as the basis for credit by examination in Mathematics 305G. Such credit will satisfy degree requirements in the same way as credit earned by passing a course, except that it will not count as credit earned in residence. Although you may take tests before you enroll in U.T. Austin, you must be a currently or previously enrolled student in order to receive credit. Unsuccessful attempts to earn credit by examination will not become part of your official academic record.

TEST IS REQUIRED OF MOST STUDENTS FOR COURSE PLACEMENT

A specific minimum score on the Math Level I (or Level II) Test is a prerequisite for many Mathematics Department courses (see *Course Schedule*). In addition to those students who need to have a specific minimum score, all others are required to have a score report in hand at the time they register for any lower-division course in the Department of Mathematics, with three exceptions.

Exceptions:

1. College of Engineering students who have college credit for calculus;
2. Non-engineering students who have either a) completed a Mathematics Department course at the University with a passing grade, or b) received credit by examination from the University for a Mathematics Department course, or c) received transfer credit equivalent to a U.T. Austin Mathematics Department course;
3. Graduate students who have received college credit elsewhere for a mathematics course that would be accepted by the University as transfer credit in the Mathematics Department.

TYPES OF SCORE REPORTS

If the Math Level I Test is required of you, you will be permitted to register for a lower-division course only if you present a report showing your test score. At the time you register (or preregister), you must literally have a score report in hand. You must also save your score report and show it to your instructor during the first week of class to prove that you meet the prerequisite for the course.

The type of score report you have will depend on where you took the Math Level I Test.

A. TEST TAKEN ON THE U.T. AUSTIN CAMPUS

If you take the test on the U.T. Austin campus, you will be told at the test administration where to pick up your test-results slip, which you must present when you register for a mathematics course.

Placement and Credit by Examination: Test Taken on Campus

The results slip will give your Math Level I Test score, which is also your U.T. Austin Mathematics Placement score, and will list your credit and grade if you are eligible for credit by examination (see "Level of Performance for Credit," below).

To find out which math courses you are allowed to take and which math course you should take, use your Math Level I Test score and the information sheet "Placement in Entry-level Mathematics Courses," attached.

*Faculty members in the Department of Mathematics select the tests, set the levels of performance required for placement and credit, and specify who is required to take a test. The Measurement and Evaluation Center (MEC) assists the department by communicating policies, giving tests, and reporting credit.

Attachments:
Description of the Math Level I Test
Placement in Entry-level Mathematics Courses

MEC: 8/82

B. TEST TAKEN AT A COLLEGE BOARD TEST CENTER

If you took the test at a College Board Test Center (usually in a high school) on one of the five yearly nationwide test dates, then you may present the official score report you received directly from the College Board. On that report, the Math Tests are abbreviated M1 or M2.

If you do not have your own copy of the College Board report, you should ask the Measurement and Evaluation Center for a written verification of your score before going to register for a lower-division mathematics course.

If your score is high enough to warrant credit by examination, you should have the College Board send its official report of your score to U.T. Austin, provided you have not already done so. (Most prospective students list the U.T. Austin score-recipient number, 6882, when they register to take the Math Level I Test.) Although your own copy of a College Board report can serve as verification of your score in order for you to register for mathematics, only an official report received by U.T. Austin directly from College Board can be used to award course credit.

Placement and Credit by Examination: Test Taken at CB Test Center

If you took your test at a College Board Test Center during or after May, 1980, special circumstances require that you take three steps to find out what mathematics course you should take and whether or not you are eligible for credit by examination.

1. Change your College Board Score into a U.T. Austin Mathematics Placement Score in this manner.

If your College Board Mathematics Achievement Test Score, Level I or Level II, is	Add these points to your College Board Score	Your U.T. Austin Mathematics Placement Score is
660 – 800	Add 30 points	690 – 830
470 – 659	Add 20 points	490 – 679
290 – 469	Add 10 points	300 – 479
200 – 289	Add no points	200 – 289

2. Find out whether or not you are eligible for credit by examination. Use your U.T. Austin Mathematics Placement Score to find your level in the table "Level of Performance for Credit," given below.
3. Find out which mathematics course you should register for. Use your U.T. Austin Mathematics Placement Score and the information sheet "Placement in Entry-level Mathematics Courses," attached.

If you took your test at a College Board Test Center before May, 1980, you will need to follow a slightly different procedure. Ask the Measurement and Evaluation Center for the information you will need.

TEST SERVES AS A BASIS FOR CREDIT BY EXAMINATION IN M 305G

Mathematics 305G, Elementary Functions and Coordinate Geometry, is considered a "pre-calculus" course. It is offered for students who need to strengthen their mathematical skills before they study calculus. The course is described as "the study of elementary functions, their graphs and applications including polynomial, rational, and algebraic functions, exponential, logarithmic, and trigonometric functions."

ELIGIBILITY FOR CREDIT BY EXAMINATION IN M 305G

To be eligible to earn credit for M 305G, you must meet these requirements:

1. You must have either a U.T. Austin Mathematics Placement Score of 580 or above or a Math Level I (or Level II) Test Score of 580 or above.
2. You must not have a grade or grade symbol (CR, Q, X, W) for M 305G or an equivalent course. (M 305G and M 304 or M 304E cannot both be counted.)
3. You cannot claim credit by examination for M 305G if you took the Math Level I Test after having completed a college calculus course with a grade of C or better. This requirement does not apply to calculus credit earned by examination. If you take a calculus test and earn credit by examination, you may subsequently take the Math Level I Test and earn credit for M 305G.

LEVEL OF PERFORMANCE FOR CREDIT:

Math Level I (or Level II) Score/U.T. Austin Mathematics Placement Score	U.T. Austin Course Credit, Grade
700–800	M 305G with grade of A
620–699	M 305G with grade of B
580–619	M 305G with grade of C
below 580	Scores used for placement, though not for credit

WHERE AND WHEN TO TAKE THE MATH LEVEL I TEST

You may take the test either in a College Board Test Center on a nationwide test date or on the U.T. Austin campus on a date set by U.T. Austin.

COLLEGE BOARD TEST CENTERS

- These centers are usually high schools. *Test dates* are usually in November, December, January, May and June of each year. Advance registration with the College Board is required.
- *Test scores* from College Board nationwide administrations are typically available about five weeks after the test date.
- The *test fee* for one, two, or three Achievement Tests taken on the same date is $16.75.
- The College Board *Student Bulletin,* which includes a list of test centers and a registration form, is available without charge at most high schools or from the College Board ATP, Box 592, Princeton, N.J., 08541.

U.T. AUSTIN TESTING

- U.T. Austin offers the Math Level I Test for students and prospective students during *scheduled testing periods:* several days before registration for the first summer term, during each Summer Orientation Session, and several days before registration for the fall and spring semesters. It is also given toward the middle of the fall and spring semesters.
- *Test results* from U.T. Austin administrations are available within several days after the test date, in most cases before a student's assigned class-registration time. The specific time and place will be announced at the test administration.
- The *test fee* for each Achievement Test is $20.00 (subject to change). Students pay the fee before the actual test time at the location and times listed in the test schedule for a particular test period. Ordinarily, the fee can be paid on the day of the test. No other advance reservation is required. For some test periods, students can register in advance by mail; when advance registration is possible for a particular test period, the test schedule will give details.
- Students with a significant degree of documented financial need are eligible for waiver of a reasonable number of test fees (contact Office of Student Financial Aid). In order to receive a test-room admission slip, students present fee waivers at the place where fees are paid.
- U.T. Austin *test schedules* will be available no later than one month before the beginning of each test period.

Requirements for Taking the Test on the U.T. Austin Campus
You must pay the test fee before the test time.
You must present at the test room a generally accepted identification bearing both your signature and photograph. Without it, you will be admitted only if you submit a recognizable photograph of yourself, which will not be returned to you.
You should take several sharpened No. 2 pencils to the test room; all other test materials will be provided.

REPEATING THE MATH LEVEL I TEST

You may take the Math Level I Test on our campus twice. The second time, however, cannot be during the same time period. The time periods are these: January through April, May through July, August through December.

In College Board Test Centers, you may repeat the test as often as you wish. (You may take the test twice at U.T. Austin regardless of how many times you take the test in College Board Test Centers.)

CALCULUS: OPTIONAL TESTS USED BY U.T. AUSTIN

Course Credit	Test Used
Mathematics 808A First-semester calculus	CLEP Subject Examination in Calculus with Elementary Functions, or College Board Advanced Placement Examination in Calculus–AB
Mathematics 808A and 808B First and second-semester calculus	College Board Advanced Placement Examination in Calculus–BC

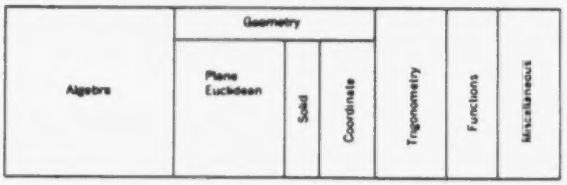
Additional information is available from the Measurement and Evaluation Center.

DESCRIPTION OF COLLEGE BOARD ACHIEVEMENT TEST IN MATHEMATICS LEVEL I

Special Eligibility Requirements

- To be eligible to earn credit by examination in Mathematics 305G, you cannot have a grade or grade symbol (CR, X) for M 305G or an equivalent course. (M 305G and M 304 or M 304E cannot both be counted.)
- You cannot claim credit by examination for M 305G if you took the Math Level I Test after having completed a college calculus course with a grade of C or better. This requirement does not apply to calculus credit earned by examination. If you take a calculus test and earn credit by examination, you may subsequently take the Math Level I Test and earn credit for M 305G.

The diagram to the right shows approximately how the questions are distributed among the major curriculum areas.



Test Description

The Level I examination is a broad-range, cumulative test. Questions are based on topics usually covered in the first three years of a college preparatory mathematics sequence. About half the questions deal with topics from algebra and plane Euclidean geometry; the rest cover some aspects of coordinate geometry, trigonometry, functions and functional notation for composition and inverse, space perception of simple solids (including mensuration formulas), mathematical reasoning, and the nature of proof. It is not expected that all students will be familiar with all the topics included on any edition of the examination. This test is one hour long.

The sample questions do not describe the specific content of any test; they illustrate the kinds of mathematical knowledge and techniques required for the tests. As a general rule, trying to work a problem by testing each of the answer choices is time-consuming and, in many instances, will not work. However, you should look at the answer choices while studying the question. The form of the answer choices may help to clarify the problem.

An attempt is made to construct questions that can be understood by all students regardless of the mathematics curriculums they have studied. Symbolism has been kept simple. For example, the symbol PQ may be used to denote a line, a ray, a segment, or the measure (length) of a segment; the particular interpretation of the symbol is indicated by its context in the problem. Throughout these tests, if the rule of a function f (considered to be a real-valued function unless otherwise stated) is specified but the domain is not, then the domain of f is understood to be the set of all real numbers x for which f(x) is a real number.

Note: Figures that accompany problems in these tests are intended to provide information useful in solving the problems. They are drawn as accurately as possible EXCEPT when it is stated in a specific problem that its figure is not drawn to scale. All figures lie in a plane unless otherwise indicated.

1. If $i^2 = -1$, which of the following is an expression for $\sqrt{-49} - \sqrt{-25}$ in the form $a + bi$, where a and b are real numbers?
   (A) $0 + (\sqrt{24})i$ (B) $0 + (\sqrt{74})i$
   (C) $0 + 24i$ (D) $0 + 2i$ (E) $2 + 0i$

2. The graph of the equation $3x - 2y = 4$ intersects the Y-axis at
   (A) (0, −4) (B) (0, − 2) (C) (0, 2)
   (D) (0, 4) (E) (2, 0)

3. If $x + 2 = y$, what is the value of $|x - y| + |y - x|$?
   (A) −4 (B) 0 (C) 2 (D) 4
   (E) It cannot be determined from the information given.

4. Two rectangular solids have the dimensions 4, 6, h, and 8, 2, (2h − 1), respectively. Their volumes are equal when $h =$
   (A) $\frac{1}{8}$ (B) $\frac{4}{5}$ (C) 1 (D) 2 (E) 4

5. If $f(x) = 5x + 6$, then $f(x) < 16$ if and only if
   (A) $x < 2$ (B) $x > 2$
   (C) $x = 2$ (D) $-2 < x < 2$
   (E) x is any real number

6. If x is the measure of an acute angle such that $\tan x = \frac{k}{3}$, then $\sin x =$
   (A) $\frac{k}{3 + k}$ (B) $\frac{3}{\sqrt{9 - k^2}}$ (C) $\frac{k}{\sqrt{9 - k^2}}$
   (D) $\frac{3}{\sqrt{9 + k^2}}$ (E) $\frac{k}{\sqrt{9 + k^2}}$

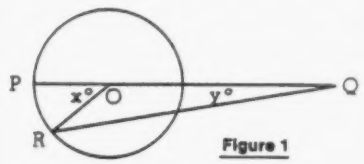


Figure 1

7. The circle in Figure 1 has center at O. If PQ and QR are secants and if $x = 40$, what is the value of y?
   (A) 10 (B) 20 (C) 30 (D) 40
   (E) It cannot be determined from the information given.

8. In how many points do the graphs of $x^2 + y^2 = 9$ and $x^2 = 8y$ intersect?
   (A) One (B) Two (C) Three (D) Four
   (E) More than four

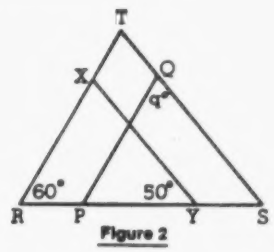


Figure 2

9. In △ RST in Figure 2, if XY is parallel to TS and PQ is parallel to RT, then $q =$
   (A) 50 (B) 60 (C) 70 (D) 110 (E) 120

10. What is the least number x such that $0 < x < \frac{\pi}{2}$ and $\sin(2x + \frac{\pi}{4}) = \cos(\frac{\pi}{6} - x)$?
    (A) $\frac{\pi}{15}$ (B) $\frac{\pi}{12}$ (C) $\frac{\pi}{10}$ (D) $\frac{\pi}{9}$ (E) $\frac{\pi}{3}$

11. If $f(x) = 2x + 1$ and $g(x) = 3x - 1$, then $f(g(x)) =$
    (A) $6x - 1$ (B) $6x + 2$ (C) $x - 2$
    (D) $5x$ (E) $6x^2 + x - 1$

12. If h, k, m, and n are positive numbers, k is greater than m, and n is greater than h, which of the following are true?
    I. $k + h$ is greater than $m + n$.
    II. $k + n$ is greater than $m + h$.
    III. $k + m$ is greater than $n + h$.
    (A) None (B) I only (C) II only
    (D) I and II only (E) I, II, and III

13. If the following instructions to a computer are carried out in the order specified, what value of S should be written in instruction 6?
    1. LET S = 0
    2. LET X = 5
    3. LET THE NEW VALUE OF S EQUAL THE OLD VALUE OF S PLUS THE VALUE OF X
    4. INCREASE THE VALUE OF X BY 2
    5. IF X < 8, GO BACK TO INSTRUCTION 3. OTHERWISE GO ON TO INSTRUCTION 6
    6. WRITE THE FINAL VALUE OF S
    (A) 0 (B) 5 (C) 7 (D) 9 (E) 12

14. $\log_2 25$ is between what pair of consecutive integers?
    (A) 1 and 2 (B) 2 and 3 (C) 4 and 5
    (D) 5 and 6 (E) 12 and 13

Answers to Mathematics Test questions
Level I

1. D	5. A	9. C	13. E
2. B	6. E	10. B	14. C
3. D	7. E	11. A	
4. D	8. B	12. C	

You may *not* use a hand calculator, a slide rule, or any other computational aid during the test.

FALL 1982 PLACEMENT IN ENTRY-LEVEL MATHEMATICS COURSES

MATH LEVEL I TEST. Scores on the College Board Achievement Test in Mathematics Level I (or Level II)* are used both to advise students as to which courses they should take and to determine which courses they are allowed to take. The advice and rules are based on comparisons of Math Level I Test scores with subsequent course grades. Although other factors—such as mathematics learned or forgotten since taking the test—affect course performance, the advice below should be followed since it is important to be prepared well for any mathematics course you take.

LOW SCORES. Most students with scores below 400 are unprepared for all Mathematics Department courses. Students with scores between 400 and 500 are unprepared for some Mathematics Department courses. See "Students Underprepared in Mathematics" on next page for details and advice on strengthening mathematics skills.

COURSES. Detailed information on the purposes and specific prerequisites of each Mathematics Department course can be found at the start of the Mathematics section in the *Course Schedule*. Most courses require a minimum score on the Math Level I Test as a course prerequisite. Since most students who enroll in Mathematics Department courses intend to take either the standard calculus (M 808)/pre-calculus sequence or the business calculus (M 403K)/pre-calculus sequence, detailed advice concerning these courses is presented below. Other courses requiring a minimum score on the Math Level I Test as a prerequisite are listed on the next page.

I. STANDARD CALCULUS (M 808A) AND PRE-CALCULUS

Prerequisite for M 808A: A Math Level I Test score of at least 580, or a grade of at least C in M 304E+ or M 305G or an equivalent course.

A. ENGINEERING STUDENTS:
You are advised by the College of Engineering to follow this placement plan based on your Math Level I Test score:

If your score is 200–499, consult an Engineering adviser on how to improve your preparation before beginning the standard calculus sequence.

If your score is 500–800 and you have not studied trigonometry, enroll in M 304E+ or M 305G.

If your score is 500–800 and you have studied trigonometry, enroll as indicated below:

Test Score	Course Placement
600–800	M 808A
580–599	M 305G recommended, but M 808A allowed
500–579	M 305G

B. NON-ENGINEERING STUDENTS:
You are advised to follow this placement plan based on your Math Level I Test score:

If your score is 200–399, see the paragraph "Low Scores" above and consult your adviser on how to improve your preparation before beginning the standard calculus sequence.

If your score is 400–499, you must take M 301+ and, later, either M 304E+ or M 305G before taking M 808.

If your score is 500–579 and you have not studied trigonometry, you must take M 304E+ or M 305G before taking M 808.

If your score is 500–579 and you have studied trigonometry, you must take M 305G before taking M 808.

If your score is 580–800, you should take M 808A.

II. BUSINESS CALCULUS (M 403K) AND PRE-CALCULUS

Prerequisite for M 403K: A Math Level I Test score of at least 500, or a grade of at least B in M 301+ or an equivalent course.

ALL STUDENTS:
You are advised to follow this placement plan based on your Math Level I Test score:

If your score is 200–399, see the paragraph "Low Scores" above and consult your adviser on how to improve your preparation before beginning the business-calculus sequence.

If your score is 400–499, you must take M 301+ before taking M 403K.

If your score is 500–599, you should take M 403K.

If your score is 600–800, you may take M 403K but should consult your adviser on whether M 808A might be more appropriate for you.

*Although Mathematics Level I is the required test, students may instead present a score on the CB Achievement Test in Mathematics Level II.

+M 301 is College Algebra; M 304E is Trigonometry.

III. OTHER COURSES REQUIRING A SPECIFIC MINIMUM TEST SCORE

M 305G—Elementary Functions and Coordinate Geometry (pre-calculus)
M 304E—Trigonometry (offered only in summer)
Prerequisite to either course: Math Level I Test score of at least 500, or a grade of at least a B in M 301 or an equivalent course.

M 407—Mathematics for Architects (open to architecture students only)
Prerequisite: Math Level I Test score of at least 500 and knowledge of trigonometry, or M 304E or M 305G or an equivalent course.

M 301—College Algebra (offered only in summer)
M 316K—Topics in Elementary Math (for elementary school teachers and other students whose degree programs require this course)
Prerequisite to either course: Math Level I Test score of at least 400.

IV. SOME COURSES REQUIRE THE TEST BUT NO MINIMUM SCORE

Although no specific minimum score is required for courses such as M 302—Introduction to Math, M 303F—Mathematics of Investment and M 316—Elementary Statistical Methods, most students must present a score on the Math Level I Test. (Test requirement is given in *Fall 1982 Course Schedule.)*

FOR STUDENTS UNDERPREPARED IN MATHEMATICS

Students with weak backgrounds in mathematics need to improve their basic mathematics skills before enrolling in a U.T. Austin Mathematics Department course. In particular:

1. **Students who score below 400** on the College Board Achievement Test in Mathematics Level I or II probably are not prepared for—nor will they be allowed to take—almost ANY such course, and probably should take a solid course in Intermediate Algebra before taking the Math Level I Test again.

2. **Students who score between 400 and 500** on the Math Level I Test, although prepared for some courses, are not prepared for—nor will they be allowed to take—certain courses such as trigonometry (M 304E), pre-calculus (M 305G), and calculus (M 403K, M 608E, M 808A), and must improve their Math Level I Test score or perform well in a College Algebra course (M 301) before taking any of those courses.

Math Level I Test score prerequisites for various courses are given above.

Such courses as Intermediate Algebra and College Algebra are offered in many community colleges, junior colleges, and other educational institutions; students needing improvement in algebra or other basic mathematics skills are strongly advised to enroll in such a course at an institution of their choosing. For students seeking to do so while in Austin, there are some appropriate courses available from institutions in the city:

1. The U.T. Austin Mathematics Department offers College Algebra and Trigonometry during the summer sessions only. Self-help instructional materials and limited brief-review non-credit classes are also available on the U.T. Austin campus through RASSL/Learning Services, 512/471-3614. High-school-level (or intermediate) courses are offered by U.T. Austin's Extension and Correspondence Division, 512/471-5616.

2. Austin Community College regularly offers Intermediate Algebra, College Algebra, and Trigonometry; for information, contact Dr. S. Rodi in Mathematics at ACC's Rio Grande campus, 512/476-6381.

3. Huston-Tillotson College also regularly offers Algebra and Trigonometry; for information, contact Dr. G. Marshall in Mathematics at Huston-Tillotson, 512/476-7421.

Mathematical literacy is important for all educated persons, whether or not they intend to pursue a technical plan of study or career. Students wanting advice on what Mathematics Department courses to take are encouraged to study the placement information given above and to consult with a Mathematics Department adviser after receiving a Math Level I Test score. Note that, with rare exceptions (see *Course Schedule* for details), students must have a score on this test BEFORE they can register for a Mathematics Department course. And those with weak backgrounds should strengthen that background before taking Mathematics Department or other technical courses at U.T. Austin.

James W. Daniel
Chair, Mathematics Department
Spring, 1982

APPENDIX B

Seven Questions About Prior Study of Physics and General or Natural Science

Group Profiles: Tables A and B

Physics 303K: Seven Questions About Prior Study of Physics and General Science or Natural Science in High School and/or College

91. In high school (grades 9-12), how many courses in General Science or Natural Science did you take?

A. None
B. Less than one year (one semester; one or two quarters)
C. One year (two semesters; three quarters)
D. More than one year

92. In high school (grades 9-12), how many courses in Physics did you take?

A. None
B. Less than one year (one semester; one or two quarters)
C. One year (two semesters; three quarters)
D. More than one year

93. In college (U.T. Austin or elsewhere), how much credit by examination in Physics have you already earned?

A. None
B. Less than one year (one semester; one or two quarters)
C. One year (two semesters; three quarters)
D. More than one year

94. In college (U.T. Austin or elsewhere), how many courses in General Science or Natural Science have you already taken?

A. None
B. Less than one year (one semester; one or two quarters)
C. One year (two semesters; three quarters)
D. More than one year

95. In college (U.T. Austin or elsewhere), how many courses in Physics have you already taken?

A. None
B. Less than one year (one semester; one or two quarters)
C. One year (two semesters; three quarters)
D. More than one year

96. Have you already earned any college credit (at U.T. Austin or elsewhere), including credit by examination, in Calculus?

A. Yes
B. No

97. Are you taking this course, PHY 303K, for the first time?

A. Yes
B. No

8-31-82

Table A

Group Profiles Based on Responses of Total Group (N = 580)[a] and Select Subgroup (N = 283) of Students to Seven Questions About Prior Study of Physics and General or Natural Science in High School or College

Item	Group	Responses					Total Number of Responses
		None	Less than One Year	One Year	More than One Year	Other	
1. High school general/natural science courses	Total	16 (3%)	8 (1%)	87 (15%)	459 (80%)	3 (1%)	573 (100%)
	Select	9 (3%)	3 (1%)	35 (12%)	235 (83%)	1 (<1%)	283 (99%)[b]
2. High school physics courses	Total	102 (18%)	22 (4%)	385 (67%)	64 (11%)	--	573 (100%)
	Select	20 (7%)	5 (2%)	225 (80%)	33 (12%)	--	283 (101%)[b]
3. Credit by examination in physics	Total	545 (95%)	16 (3%)	9 (2%)	1 (<1%)	1 (<1%)	572 (100%)
	Select	276 (98%)	4 (1%)	1 (<1%)	1 (<1%)	1 (<1%)	283 (99%)[b]
4. College general/natural science courses	Total	382 (67%)	48 (8%)	83 (15%)	59 (10%)	--	572 (100%)
	Select	255 (90%)	11 (4%)	15 (5%)	2 (1%)	--	283 (100%)
5. Prior college physics courses	Total	464 (81%)	81 (14%)	24 (4%)	4 (1%)	--	573 (100%)
	Select	283 (100%)	0 (0%)	0 (0%)	0 (0%)	--	283 (100%)

Item	Group	Responses		Total Number of Responses
		Yes	No	
6. Prior college credit in calculus	Total	224 (39%)	349 (61%)	573 (100%)
	Select	57 (20%)	226 (80%)	283 (100%)
7. Physics 303K for the first time	Total	531 (93%)	39 (7%)	570 (100%)
	Select	283 (100%)	0 (0%)	283 (100%)

[a] The maximum number of responses received from the Total Group (N = 580) to any one question was 573.

[b] This figure differs from 100% only because of rounding error.

Table B

Group Profiles Based on Three Variables Obtained from University Records for Total Group (N = 580) and Select Subgroup (N = 283)

Variable	Response	Group			
		Total Group		Select Subgroup	
		N	%	N	%
Sex	Men	467	81%	229	(81%)
	Women	113	19%	54	(19%)
Classification	Freshman	348	60%	245	87%
	Sophomore	157	27%	32	11%
	Junior	43	7%	5	2%
	Senior	30	5%	1	<1%
	Graduate	2	<1%	0	0%
College of Enrollment	Engineering	509	88%	283	100%
	Natural Sciences	25	4%	0	0%
	Liberal Arts	21	4%	0	0%
	Business	10	2%	0	0%
	Architecture	9	2%	0	0%
	Education	3	1%	0	0%
	Graduate School	2	<1%	0	0%
	Communication	1	<1%	0	0%

APPENDIX C

Decisions of Department of Physics
Regarding Physics 306

THE UNIVERSITY OF TEXAS AT AUSTIN
AUSTIN, TEXAS 78712

Department of Physics

February 20, 1984

Dr. Charles A. Sorber
Associate Dean for Academic Affairs
College of Engineering
ECJ 10.316

Dear Dean Sorber:

The Measurement and Evaluation Center, at the request of the Department of Physics, has done an analysis of the effectiveness of the Physics 306 course in providing remediation for incoming freshman engineering students. I attach a table summarizing the relationship of the Mathematics, Level I, scores of freshman engineers and their performance in introductory physics courses. The study supports the use of the Mathematics, Level I, test as a screen for entry to Physics 303K and the use of Physics 306 as a buffer. Students in the interval 200-600 on Mathematics, Level I, have almost a 50% chance of failure if they enter 303K directly, whereas 75% of the students in this same interval who choose to enroll in 306 succeed. The predictive capabilities of the Mathematics, Level I, test is not so good that we wish to implement a prerequisite of scoring higher than 600 for entry into Physics 303K, but it is clearly a superb advising aid.

I would appreciate your circulating this information among the engineering advisers, telling them that we strongly urge that they counsel all incoming freshmen who score below 600 in the Mathematics, Level I, test to register in Physics 306.

Additionally, after consultation with Dr. Meyer, we have decided to add a second six-week session of Physics 306 to the summer course schedule. This course, to be taught by Dr. Karl Trappe, is scheduled for the second summer session. This offering will allow weaker students to overcome their deficiencies and greatly improve their chances of surviving in the engineering curriculum without any delay in their programs.

Sincerely yours,

Austin M. Gleeson
Interim Chairman

AMG/sk
Attachment